

# Impact of Managerial Skills on Innovative Projects' Management Processes in the Domain of Mining Machines

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**Abstract**

The article presents the role and significance of managerial skills in the management of innovative projects oriented toward mining machines and equipment for the underground exploitation of minerals. Based on the Authors' multi-year experience gained at the KOMAG Institute of Mining Technology, the shaping of managerial skills and impact techniques are described. Different aspects of impact techniques such as an auto presentation, a presentation, arts of negotiations and business etiquette are highlighted. Group dynamics, a process of team creation, sources of leader's knowledge, settlements of conflicts, "brain-storming", as well as methods of taking decisions are analysed from the perspective of successful management of innovative projects. The article ends with some guidelines to avoid errors in project management processes.

**Keywords**

Managerial skills, management, innovative projects, mining machines



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## INTRODUCTION

Classic project management tools have been used in the same way for decades, but this classic approach is now being supplemented or replaced by new methods to cope with the increasing speed of change and challenges, which must be mastered, so agile project management should be used. It is essential to have a highly qualified and passionate team that works together closely, adapts quickly to changing situations and organises itself. Differences between classic and agile project management are shown in Fig. 1.

Classic project management		Agile project management
<ul style="list-style-type: none"> <li>Requirements are apparently, known from the start.</li> </ul>	↔	<ul style="list-style-type: none"> <li>Requirements are blurred at the beginning and they are treated accordingly.</li> </ul>
<ul style="list-style-type: none"> <li>Changes in requirements during the project are not planned.</li> </ul>	↔	<ul style="list-style-type: none"> <li>Changes in requirements during the project are planned and welcome.</li> </ul>
<ul style="list-style-type: none"> <li>Changes in requirements (change requests) are associated with high additional costs.</li> </ul>	↔	<ul style="list-style-type: none"> <li>Later changes in requirements are planned from the start and only cause low additional costs.</li> </ul>
<ul style="list-style-type: none"> <li>Requirements are primarily described as “technical” (“domain of the technicians”).</li> </ul>	↔	<ul style="list-style-type: none"> <li>Requirements are consistently described from the user perspective (“user stories”).</li> </ul>
<ul style="list-style-type: none"> <li>The development process is sequential.</li> </ul>	↔	<ul style="list-style-type: none"> <li>The development process is iterative and incremental.</li> </ul>
<ul style="list-style-type: none"> <li>The project management process follows clear and unchangeable rules and standards.</li> </ul>	↔	<ul style="list-style-type: none"> <li>The project management process is continuously optimized based on experiences.</li> </ul>
<ul style="list-style-type: none"> <li>The customer only sees the final result, not intermediate results.</li> </ul>	↔	<ul style="list-style-type: none"> <li>The results are continuously presented in the customer to obtain feedback.</li> </ul>
<ul style="list-style-type: none"> <li>If there is a problem during the project, defined milestones are shifted.</li> </ul>	↔	<ul style="list-style-type: none"> <li>If difficulties arise, the focus is increased and a problem solution is sought immediately.</li> </ul>
<ul style="list-style-type: none"> <li>Large teams with a strict hierarchical structure are used (tasks are assigned from above).</li> </ul>	↔	<ul style="list-style-type: none"> <li>Small teams are used, which organize themselves to a large extent (tasks are taken independently).</li> </ul>
<ul style="list-style-type: none"> <li>The members of the development team are proven specialists.</li> </ul>	↔	<ul style="list-style-type: none"> <li>In addition to expert knowledge, the team members also have general knowledge (“T-format”).</li> </ul>
<ul style="list-style-type: none"> <li>The team members are physically separated and work on different projects at the same time.</li> </ul>	↔	<ul style="list-style-type: none"> <li>The team sits in one room and focuses on one project.</li> </ul>
<ul style="list-style-type: none"> <li>Communication takes place via extensive project documentation and during long meetings with extensive to-do lists.</li> </ul>	↔	<ul style="list-style-type: none"> <li>There is a high degree of informal communication, stand-up meetings are held.</li> </ul>
<ul style="list-style-type: none"> <li>The cost estimation is made by the project manager or experts.</li> </ul>	↔	<ul style="list-style-type: none"> <li>The cost estimation is carried out consensually in the team.</li> </ul>

*Fig. 1. Differences between classic and agile project management (Kreutzer, 2019).*

It is also worth comparing previously dominant competencies, and competition required nowadays – Fig. 2.

Previously dominant competencies	Competencies required nowadays
<ul style="list-style-type: none"> <li>Extrapolative procedure in the sense of “more of the same”.</li> </ul>	<ul style="list-style-type: none"> <li>Disruptive thinking and acting – stepping out of one’s own comfort zone.</li> </ul>
<ul style="list-style-type: none"> <li>Perfection before speed – focus on time to market.</li> </ul>	<ul style="list-style-type: none"> <li>Speed before perfection – focus on time to value.</li> </ul>
<ul style="list-style-type: none"> <li>Hierarchical organization – transactional leadership.</li> </ul>	<ul style="list-style-type: none"> <li>More intensive work through networks – transformational leadership.</li> </ul>
<ul style="list-style-type: none"> <li>Tight management over goals.</li> </ul>	<ul style="list-style-type: none"> <li>Leadership stronger through vision and “sense” (focus on purpose).</li> </ul>
<ul style="list-style-type: none"> <li>Preserving the already established.</li> </ul>	<ul style="list-style-type: none"> <li>Courage to change and to “constant change”.</li> </ul>

Fig. 2. Significant changes in the competence map (Kreutzer, 2019).

The procedure presented below is based on the values of the so-called manifesto for agile software development (Beck 2018).

- Individuals and interactions are more important than processes and tools.
- Functioning software is more important than comprehensive documentation.
- Intensive cooperation with the customer is more important than contract negotiations.
- Responding to change is much more important than simply following a plan once it has been developed.

The toolbox for agile project management should always include the Scrum Method (Preussig 2015). The term "scrum" means "crowd" in rugby. With scrum, you rely on highly qualified, interdisciplinary development teams, which strive for a precisely formulated goal. When using the Scrum methodology, you do develop not only the solution but also its planning incrementally and iteratively. As a result, the long-term plan – i.e. the product backlog is also improved with experience. The detailed plan – i.e. the sprint backlog is only created for the next short cycle. The Scrum team consists of the product owner (the internal client), the Scrum master (as coach and consultant) and the development team (Fig. 3.)

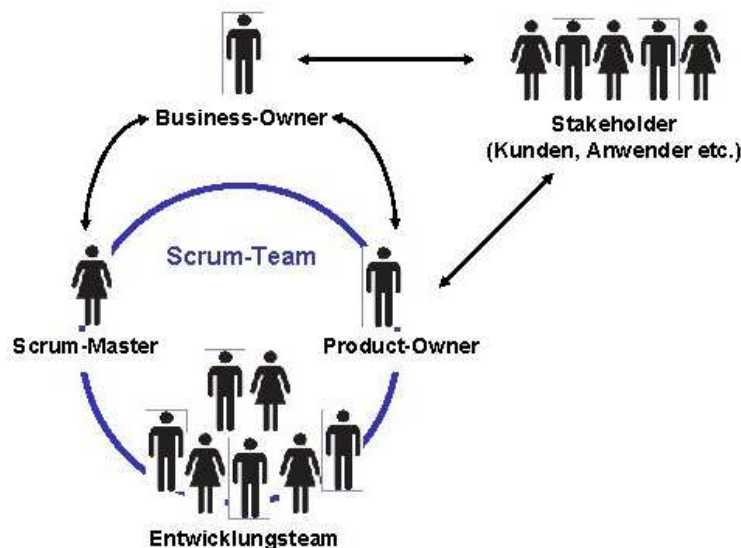


Fig. 3. Scrum team and other players (Keutzer, 2019).

Figure 3 shows an overview of the overall flow of the Scrum process. The starting point of each process is the product backlog. The iterative and incremental approach allows for essential improvements during the process. Working step by step ensures that the project’s progress and possible obstacles are recognised early and are always visible to all the participants. This significantly increases transparency in the overall project regarding the possibilities and limits of feasibility within and outside of the Scrum team, as well as within the development team itself.



Fig. 4. The overall flow of the Scrum process (Kreutzer, 2019)

A so-called burndown chart is often used to visualise the progress, thereby increasing transparency. Scrum enables to manage the overall complexity of a task more easily and quickly (Fig. 4).

Within the Scrum framework, the User Story technique is used. It enables to compile requirements for a product from the user's perspective.

At the KOMAG Institute of Mining Technology, classic project management has been used so far, but the Scrum Method is becoming increasingly common due to its unquestionable advantages. This method is applied to manage innovative projects in the domains of electronics, mechatronics and automation. The KOMAG scientists and researchers are eager to adopt this project management method, but the case is not so easy as regards the industrial partners, who are quite conservative and prefer classic project management.

## LITERATURE REVIEW

The literature review, conducted by the Authors, was oriented onto a research problem consisting of a definition of the impact of managerial skills on project management processes in the aspect of the research work efficiency. The subject matter fits in the "Production Engineering" scope because the analysed issues belong to "Engineering to Innovations". It is worth mentioning that the management of research projects is an essential element of "Production Engineering", bearing in mind that engineering is an activity consisting of cost-effective designing, construction, modification and maintenance of practical solutions to problems with the use of scientific knowledge (Malec, Stańczak 2020; Kovanič et al. 2020; Pivarčiová, 2019).

A realisation of a successful project management process is not possible without a regular assessment of the project's progress. It should be accompanied by an analysis of different scenarios, enabling long-term activities planning (Chakravorti, 2004; Chesbrough, 2006; Doddgson, 2000). There are three potential sources of knowledge: R&D collaboration, technology sourcing and technology transfer. These sources are usually quantified by means of patent data (Rassenfosse, 2020; Siegel, 2004). Kamm presented interesting information on an integrative approach to managing innovation (Kamm, 1987). It should be borne in mind that investments in scientific R&D are also subject to the risks of the "two worlds" that result from the collaboration of companies with research institutes and universities. According to the investigations carried out in Spain, there is a strong relationship between the R&D sourcing strategy of companies and innovation performance (Gomez, 2020).

The introduction and management of new technological products require specific competencies of the team involved in the process, particularly the team leader (Jakubiak 2018, Rakowska 2007). Some research was carried out to identify factors influencing the initial steps of collaboration between science and industry, based on an innovative idea developed by the researchers. Although there are different sources of information on product and process innovations, for years, the process of implementing innovative solutions has been developed under the logic of closed innovation (Gomez, 2016). Research on a new paradigm of open innovation was carried out by Chesbrough. The results are presented in (Chesbrough, 2006). He defines open innovation as "a paradigm that assumes that firms can and should use external ideas as well as internal ideas and also internal and external paths to market, as firms look to advance their technology". It should be highlighted that previous studies have shown the effect of internal and external sources of information on the novelty of product innovation (Laursen, 2006; Amara, 2005). Some examples of new rules bringing innovation to market are given in (Chakravorti, 2004).

Different indicators are used to measure the innovation process (Doddgson, 2000). 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's business attractiveness and ensures market supremacy (Adams, 2006; Arnold, 2006; Buckley, 1997). During an innovative project management process, different scenarios are constructed. They enable 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 failure. It should be highlighted that, in general, the reasons for projects' failures are not of technical nature, but they are caused by an incorrect assessment of the reasons for experienced problems (Apanowicz, 1997). In China, there are continuous debates on innovations and on managing innovative research projects (Li, 2020).

In the Authors' opinion, the ethics of introducing innovation plays a very important role. The ethical context should include an ethical decision-making framework to address ethical concerns and dilemmas from various stakeholders' perspectives (Nathan, 2015). It should be mentioned that Tidd and Bessant (2020) addressed some aspects that have ethical impacts, such as trust and legitimacy among various networks of stakeholders. As major innovation drivers and capabilities seem to ignore the approaches to the ethical decision-making process along with positive and negative impacts on society and the environment, the Authors intend to conduct their research work in this domain.

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

- analyses of national and international publications enabled us to formulate a research problem which is described in the Introduction,
- a method of multiple case study which was used for a presentation of three research projects which failed due to errors made in the management process (Lutyński, 2021),
- a heuristic method enabling to detect new facts and relationships among them (Malec and Zajac, 2021).

### **EFFICIENT MANAGEMENT OF INNOVATIVE RESEARCH PROJECTS**

The KOMAG Institute of Mining Technology has realised scientific and technical research projects of innovative character for over seventy years. The experience gained over all those years is an extremely valuable and useful source of pragmatic information for all the stakeholders of project management processes. It should be borne in mind that project management plays a key role in the efficient activity of any organisation. Good knowledge of project management principles enables risk minimisation and efficient project realisation. The project management process seems to be relatively easy theoretically; however, in practical everyday business life, it is very complicated. Correct project management requires an ability to coordinate activities, goodwill of cooperation and good communication as well as a flow of information. The reasons for difficulties in the realisation of project management processes result from organisational problems at the institute or the company, incorrect identification of business partners' expectations or needs and also an incorrect process of planning and control of realisation of individual project stages. It is worth remembering that a project is a complex activity or undertaking concerning a product or a service which has a beginning and an end; the defined objective and scope and its realisation should be under full control. The project of innovative character creates a new quality, i.e. new products or services differ from those available so far. Project management requires diversified knowledge, varied connections as well as financial, material and personnel resources.

Based on the experience gained at the KOMAG Institute, different types of projects can be distinguished, which are graphically presented in Fig. 5.

Examples of different types of projects:

- Elaboration of technical documentation of machines or equipment.
- Implementation of an innovative technical solution.
- Development of a new computer system.
- Organisation of a conference.

A key element of the project management system includes a correct determination of objectives and their consistent, constant and prompt realisation. The essence of the Management by Objectives (MBO) method requires a precise determination both of the main objective as well as intermediate objectives, so-called milestones using measurable categories. It is indispensable to check if the determined objectives are possible to be achieved. The objectives, the time frames and the conditions of the project realisation are usually determined in the contract or agreement explicitly.

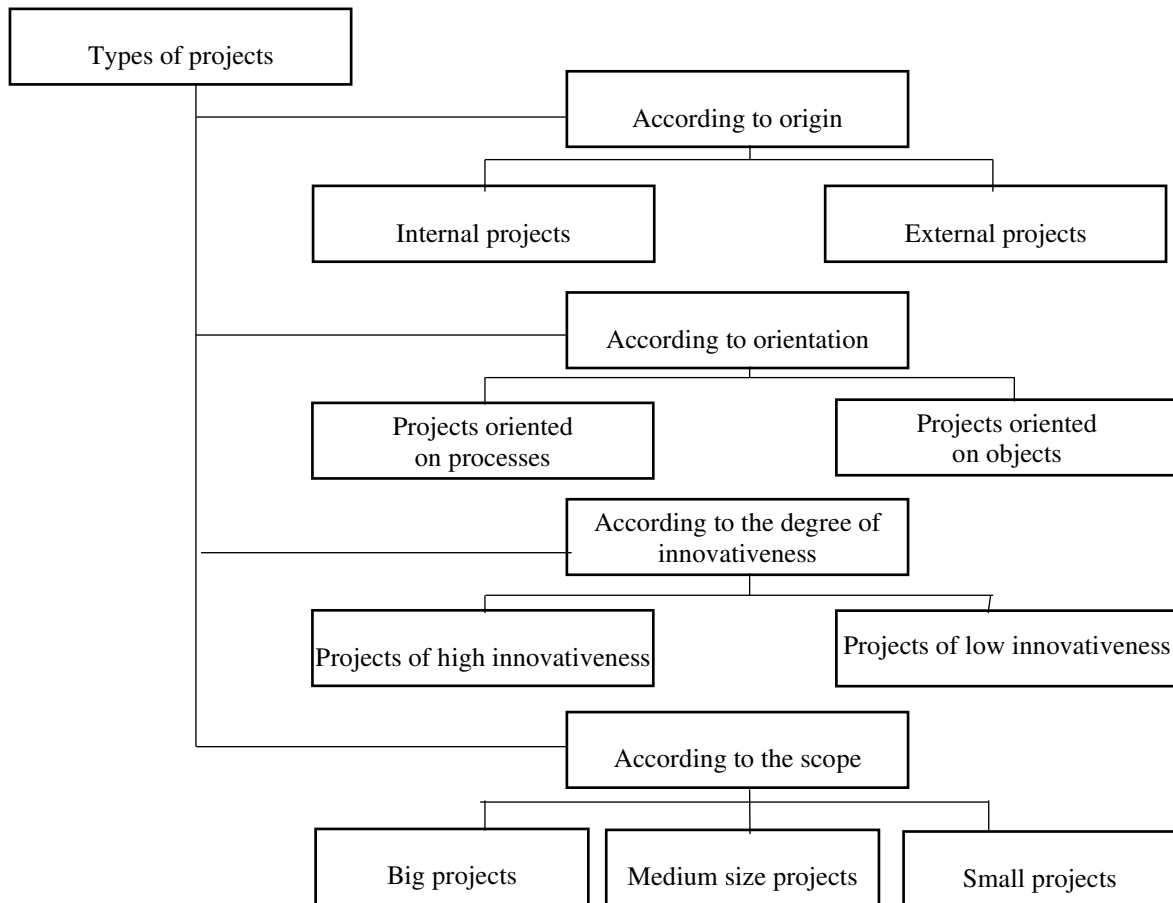


Fig. 5. Types of scientific and research projects realised at the KOMAG Institute (Authors')

It is worth mentioning that there are significant differences between a process and a project (Table 1).

Table 1. Differences between a process and a project

PROCESS	PROJECT
<ul style="list-style-type: none"> <li>• Oriented onto a stabilisation.</li> <li>• Repeatable situations.</li> <li>• Activities in accordance with the functioning management system.</li> <li>• Changes are introduced in an evolutionary way.</li> <li>• Management staff occasionally interferes in the process.</li> </ul>	<ul style="list-style-type: none"> <li>• Oriented onto changes.</li> <li>• A new situation.</li> <li>• A new management system is developed.</li> <li>• Changes are deep and quite instant.</li> <li>• Management staff takes an active part in a realisation.</li> </ul>

Presenting the differences between a process and a project, it should be mentioned that banks, offices and production facilities are mainly oriented toward processes; however, research institutes, advisory, computer and construction companies – are toward projects.

During a realisation of projects, many different problems can be experienced, such as the management of changes due to a resistance of the associates, a conflict of interests and misunderstandings resulting from multidirectional activities, quite often interdisciplinary character, time pressure due to deadlines as well as uncertainty which is connected with an insight into the future. Project Management requires a realisation of unrepeatable undertakings, i.e. an achievement of the demanded results according to the scheduled work programme and in the framework of the planned budget.

A model of project management is shown in Fig. 6.

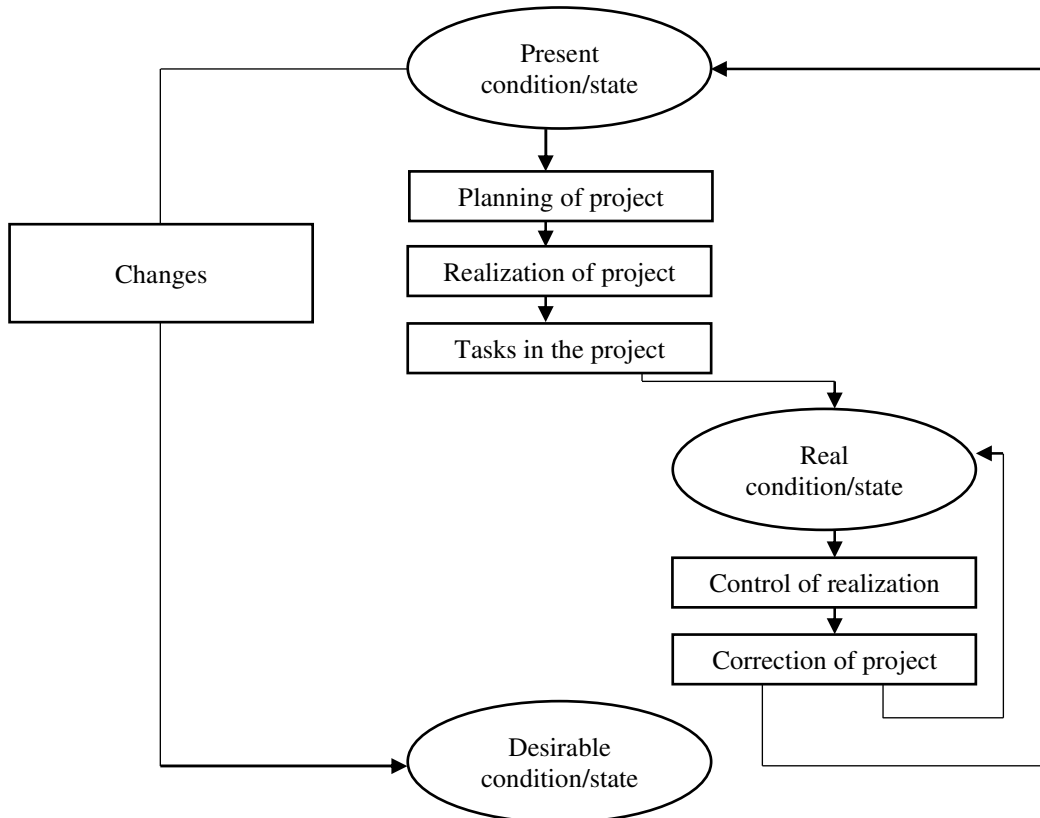


Fig. 6. Project management model (Authors')

The crucial issues in the project management process include the determined time period, the determined costs and the determining technical requirements. The project management triangle, where any two parameters determine the third one, is shown in Fig. 7.

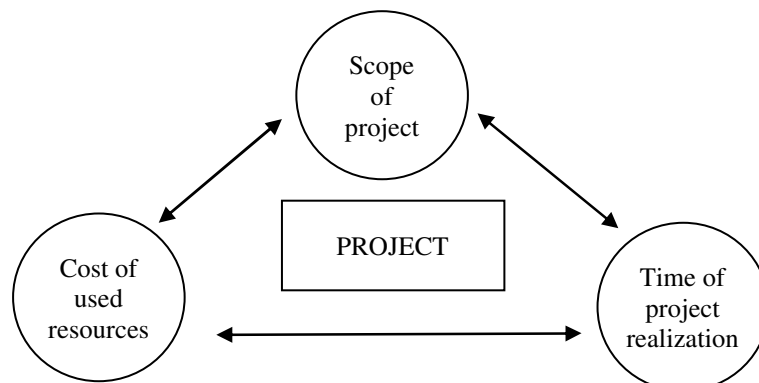


Fig. 7. Project management triangle (Authors')

The project life-cycle contains seven stages: a need/a demand, a selection of the project, planning of the project, a realisation of the project, control of the project, an assessment and termination of the project. The project leader should have the influence of organisational (formal, financial, administrative) character and personal (technical, charismatic) character. The environment of the project leader is shown in Fig. 8.

The project stakeholders are persons or organisations taking an active part in the realisation of the project or whose interests are subjected to advantageous or disadvantageous impacts resulting from a realisation or termination of the project. To the most important stakeholders belong the clients using the project's final result (product or service), an organisation realising the project, the project team and the sponsor.

It is interesting to illustrate how the project is seen by its leader as, quite often, there are significant discrepancies between his/her vision/opinion and the visions/opinions of stakeholders.

Each project leader wants to realise a task within the required timeframe, according to the scheduled work programme and ensure the required quality.

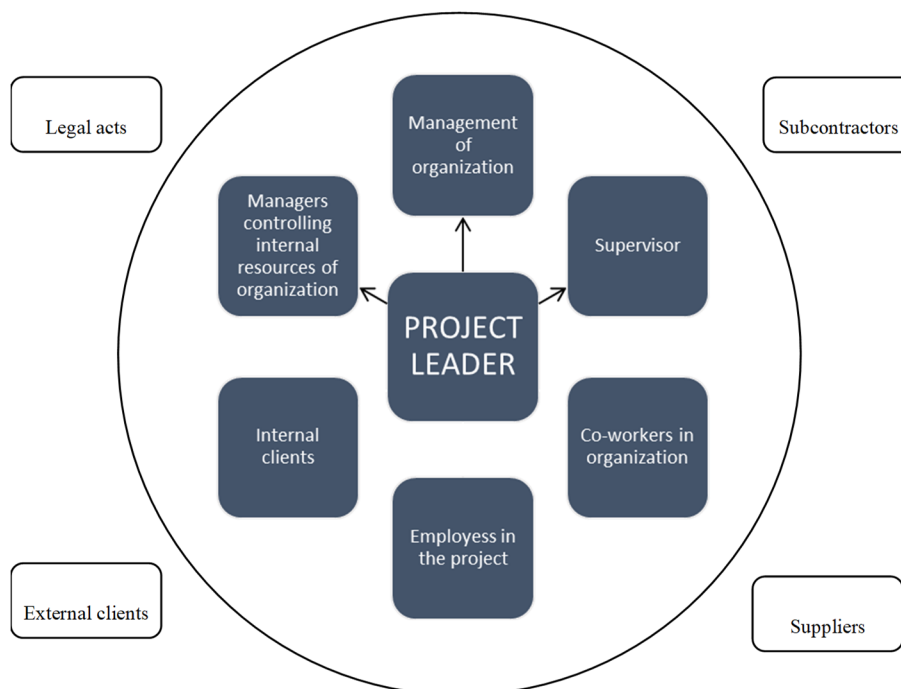


Fig. 8. Project leader's environment (Authors')

He/she wants to obtain remuneration and a positive assessment of his/her work, gain experience to be used in future projects (technology, know-how), increase his/her professional attractiveness on the market and make a positive impression on the stakeholders.

The project, seen by a member of the project team, enables him/her to show abilities and competencies indispensable for an efficient realisation of the task and to avoid a disappointment of the supervisors. He/she wants to ensure a stable future for him/her and the family, to obtain financial profits for the organisation, to maintain the position in the organisation, gain new experience and better qualifications to become more attractive on the market as well as to participate in the following projects.

The image is not full without a presentation of the project seen by the organisation board, whose members concentrate on increasing the profitability of their organisation through an increase in productivity, a reduction of failed products and a reduction of costs. They intend to maintain or, if possible, strengthen the position of the organisation, change or strengthen its image, improve the product, service or implement new distribution channels, to gain a new market share (a diversification, a change of strategy, a new group of users, a new competitor).

The project is a business undertaking, and its success depends on the abilities and competencies of the project team and on the abilities of the project leader, who is responsible for periodic reports according to the scheduled work programme, foreseeing problems during the realisation of the project and an elaboration of the strategy enabling to find solutions to experienced problems as well as reporting on expenditures according to the project budget and for ensuring good collaboration with other divisions and departments in the organisation.

### ROLE OF MANAGERIAL SKILLS – BASIC FEATURES AND ABILITIES OF THE PROJECT LEADER

It is very important to recognise the basic features and abilities of the project leader as indispensable for a successful realisation of the project management process. The basic feature of the project leader should include his/her inventiveness both regarding a selection of work methods and a selection of the ways of communication inside the project team and outside with the associates. He/she must respect other people's knowledge and different points of view of other members of the team-co-workers. It is indispensable for him/her to have influence enabling efficient project management.

The project leader needs to have managing skills and abilities, enabling him/her to choose the right members of the project team. He/she should know well how to collaborate with people and how to divide work in a just way. One of his/her abilities should include the motivation of the team and of its members as well as the execution of tasks. He/she should know how to take and convey decisions that are easy to understand. The ability to control conflicts and solve personal problems caused by professional issues plays a significant role. He/she should know how to plan his/her own time. It should also be borne in mind that the knowledge and experience in the scope of managing projects are very valuable and useful. The project leader should look in different directions to achieve the objectives – Fig. 9.



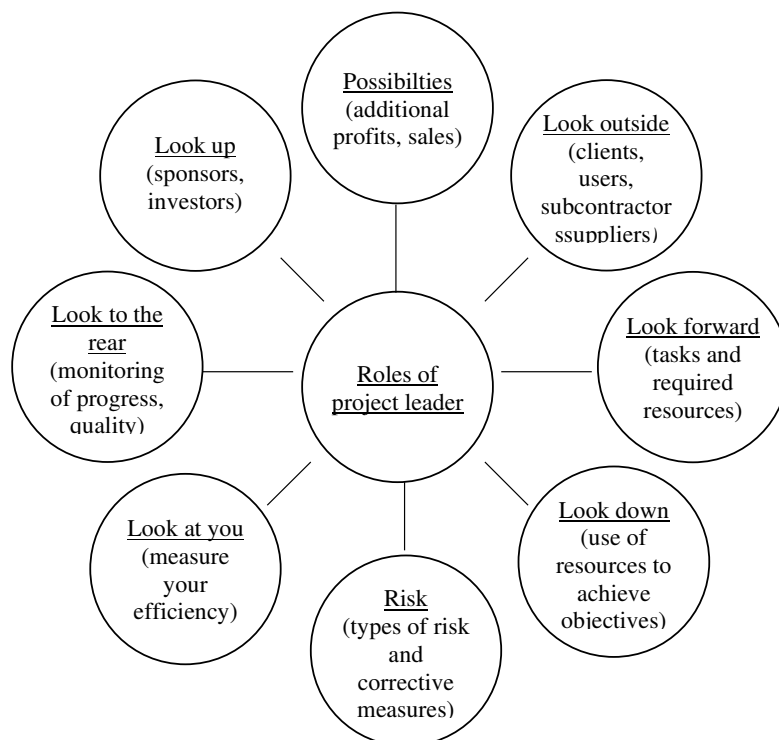


Fig. 9. Roles of efficient project leader (Authors')

As regards project leader's possibilities, it is useful to consider opportunities for gaining additional profits from additional sales. The insight outside is related to clients, users, subcontractors and suppliers, and it enables to check if the project results meet their requirements and expectations. The insight forward includes realistic activities and required resources according to the plans, but the insight down is related to the project team, and it enables to check if the resources are used in the correct way to achieve the objectives (individual, collective, external, visible, invisible, close and distant). Risk analysis enables the prevention of unwelcome issues and hazards. However, the look at the project leader himself/herself gives a chance to measure his/her efficiency, but the insight to the rear is important due to measuring the progress and quality of realised tasks. The last insight in the list, the insight up, concerns an assessment of sponsors and investors. They give resources and expect profits, but they can also help solve problems and act in difficult situations.

The project leader is responsible for the result and timely realisation of the project in accordance with its budget and the scheduled work programme, for achieving all the objectives, and for coordination of activities during the whole period of the project realisation. He should also support the professional development of the project team members, giving them advice and assistance when needed.

Among the essential abilities of the project leader, the following ones are particularly important:

- an ability of efficient leadership,
- an ability of internal and external communication,
- a negotiating ability,
- an ability to solve conflicts,
- organisational abilities,
- an ability to control stress.

Special attention should be paid to communication. It concerns different forms of communication, i.e. in writing and oral, internal (within the project team) and external (client, orderer), formal (reports), informal (notes), vertical and horizontal. A negotiating ability plays a very important role as negotiations consist of discussions oriented onto reaching an agreement concerning the conditions of the project. Usually, negotiations in the project management process concern the scope, the cost and the organisational conditions, including personnel, division of work and responsibilities of the team and of the leader. There are three styles of project management: autocratic, laissez-faire and democratic. An autocratic project leader does not analyse the information obtained from external sources, and he/she is not interested in the opinion of the team members. This management style is good for typical projects of small risk. It is efficient when a quick decision-making process is indispensable. Its disadvantages include a small impact of co-workers on the decision-making process, and the leader gets only partial information, so there is a serious risk of taking wrong decisions by him/her. It is difficult to say which management style is

most advantageous, so the leader should not apply only one management style exclusively. A decision about selecting the management style depends on the type of project and on the orderer's requirements. During the project planning, the laissez-faire style seems to be most favourable, whereas during the realisation phase, the democratic style is best; however, in difficult situations - the autocratic style is helpful.

A successful realisation of the project depends on four general factors: searching for solutions and not the guilty ones, orientation onto intermediate objectives, a concentration on meeting the orderer's requirements, and orientation on the final objective. Among the critical factors, correct selection of the team members, correct communication inside the team, constructive solution to problems, relief of tension and of conflicts, correct realisation of the scheduled work programme, control of tasks realisation, consultations with orderers, obtaining the final approval of the orderer for the project results, should be named. The project success measure is its realisation in the scheduled time and within the planned budget, achieving the planned objectives. The client's satisfaction is the final measure of success. Many projects fail due to incorrect management and an incorrect definition of the client's needs or technical requirements formulated incorrectly.

As it has already been highlighted, the project's risk management is subject to identifying and controlling areas or events that can lead to unwelcome changes. The risk is an accumulated effect of the probability of events occurring, which may have a disadvantageous impact on the project realisation. The risk management in the project is in this indispensable, and it should be systematic. A risk concerns a failure in a realisation of the objective as regards quality and orderer's requirements but also a failure in a realisation of budget assumptions. The risk can be identified with the use of different tools and methods such as a review of technical documentation, a database containing the essential information and also check-up surveys. There are four typical reactions in the case of detecting a risk:

- avoid a risk (give up a project realisation, choose a different partner etc.),
- mitigate a risk,
- transfer a risk (invite other partners or buy insurance protecting against responsibilities),
- accept a risk (passive method and active method consisting in a generation of reserves).

As it has already been highlighted, the project leader should know very well how to realise quality management in the project. The Total Quality Management system is common. It consists of using abilities, tools, techniques and processes to identify clients' needs and expectations and choosing the best methods to fulfil them. The basic principles of the TQM system used in the project management process include a concentration on the client's needs, an orientation on objectives and an orientation on people in general.

Even in the case of most experienced and fully qualified project leaders, some deviations between the plan and the real condition/state of the project occur. During the project realisation, some deviations from the plan can be tolerated, whereas it is inadmissible to exceed the project realisation time and its budget at the end of the project. The project leader should take only well-thought-over decisions. He/she should be able to foresee problems, avoid self-deception, and investigate the truth. Considering the complex circumstances of the project management process, controlled flexibility can be an advantage.

Summing up the requirements concerning the project leader's competencies and abilities, he/she should know how to manage the project scope, time of realisation, costs, human resources, risk, quality and communication.

### **IMPACT OF PROJECT LEADERS' MANAGERIAL SKILLS ON THE SUCCESS OF INNOVATIVE RESEARCH PROJECTS – CASE STUDIES**

Within the research work, the Authors investigated 25 successful projects realised at the KOMAG Institute of Mining Technology from the point of view of their leaders' managerial skills. From this set, three different cases were chosen to formulate assessments of a general character. In the process of analysis, the following factors were taken into consideration:

- project initiators,
- principles of financing (targeted project, institute's financial means + entrepreneur's means),
- industrial partners (orderer: big company, SME),
- executors of laboratory and in-situ tests (institute, scientific partner, industrial partner),
- collaborating institutions: universities, big companies, SMEs, end-users-mines of minerals,
- planned costs,
- planned realisation periods: start/end,
- types of contracts and agreements,
- reports (management of changes),
- number of implementations,
- levels of royalties,
- factors contributing to a successful management process.

Selecting three projects for further analysis, the Authors concentrated on the crucial role of agreements and contracts, the significance of a proper and correct realisation of the project management process, including the process of managing changes and correct recognition of industrial partners' needs and expectations. The human factor's impact was also analysed because, in many cases, it has a decisive impact on the success or failure of a technical project of innovative character.

- A longwall shearer external spraying system ensures safe operation in the methane hazard conditions.

The project was initiated as the result of demand from the State Mining Authority. The knowledge resources were analysed very thoroughly, and the market survey was carried out. It should be highlighted that the future user, i.e. the Board of the Jastrzebska Coal Company, JSC took an active part in negotiating the conditions of the so-called targeted project, including the technical requirements and the project financing. The scheduled work programme was mutually agreed upon. Then contracts with producers were signed. All the obligations of the parties were presented in detail, including the approval of the State Mining Authority. The project management process went smoothly due to an engagement of all the stakeholders, i.e. KOMAG as an institute developing an innovative solution, the producers and the end-users from the JSW mines. The first industrial implementation took place at the Pniówek mine. Then a license agreement was signed with the producers. It also covered the Authors' supervision and the product improvement during its life.

Financial profits were obtained both by KOMAG (royalties) as well as by the producers of the system. A correctly conducted project management system ensured a timely and successful realisation of the scheduled work programme.

- System for identification of powered roof support components

This novel technical solution was developed by KOMAG in collaboration with the Silesian Technical University and the ELSTA Company. In the case of this project, special attention was paid to the management of changes and to taking corrective measures. Active marketing activities were conducted by KOMAG in coal companies.

As has already been mentioned above, all the initial steps, such as analysing the knowledge resources, confirming the market demand, and generating an innovative idea in the result of research results, were undertaken. Then participation of a producer was considered, and a consortium was built. In the targeted project application, the financial conditions of collaboration were specified in detail. Negotiations of contracts with the project partners played a crucial role which positively impacted the project management process, including corrective measures resulting from the availability of new generation identifiers on the market. As it has already been mentioned, promotional activities oriented onto producers of powered roof supports such as TAGOR, FAZOS, HYDROMEL, HYDROTECH, GLINIK and onto end-users from coal companies were extremely efficient. Before starting the project, principles and conditions of paying royalties were agreed upon among the parties, which enabled to avoid conflicts and misunderstandings during the project realisation.

- Small-size WMD-150 rig

The project was initiated by the industrial partner who carried out the market survey, which confirmed demand for designing and manufacturing a drilling rig for geological and exploratory as well as other boreholes. Its advantage was the possibility of drilling boreholes in different directions. It should be highlighted that in the case of this project, the correct management of changes played an important role as regards the successful realisation of this project. The first steps included an analysis of the knowledge resources, a confirmation of the market demand for an innovative technical solution and then a novel concept was developed with the participation of the producer. Then as the result of negotiations, a contract was formulated that precisely stipulated the financial conditions and obligations of the parties. During the project realisation, it was indispensable to introduce some changes concerning the financial conditions and the reduction of the project duration time due to end-users requirements. Annexes were signed, enabling the management of the abovementioned changes. The third annexe concerned an electronic version of technical documentation. The ZMUW producer carried out a current assessment of technical and technological solutions suggested by KOMAG, which positively impacted the commercial success of this product.

In all the three successful technical projects of innovative character and impact of a human factor has not been subject to analysis, assuming that the role of this factor is included in individual activities, oriented onto an immediate reaction to perceived issues, correct management of changes and a responsible approach to the tasks under realisation.

## IMPROVEMENT OF MANAGERIAL SKILLS – FINAL REMARKS

From the former chapters, it is possible to conclude that errors can be made at different stages of innovative projects' management processes. However, it is worth highlighting the significance of the process intended creation of the project team (Fig. 10) and the stages of creating teams.

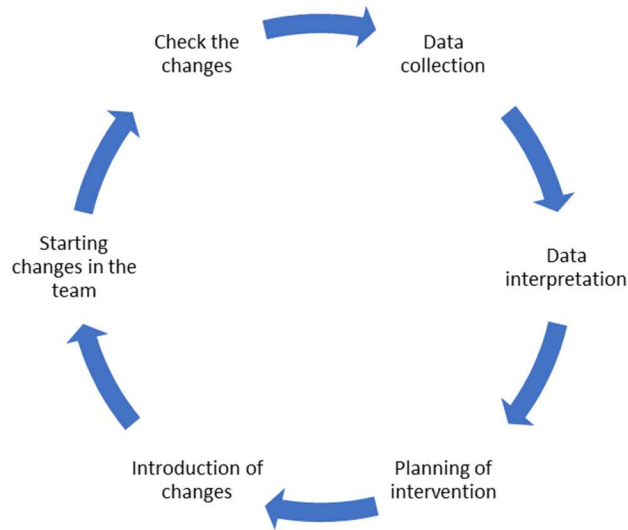


Fig. 10. The process intended for the creation of the project team.

It should be mentioned that there are five stages of creating teams: FORMING, STORMING, PERFORMING and TERMINATION OF ACTIVITY – DISSOLUTION OF TEAM. The stage of forming includes uncertainty, dependence on the leader's testing of situation/task/kind of accepted behaviour, in the stage of storming – a conflict, and emotional resistance to the requirements resulting from the task to be accomplished, a resistance to the leader and sometimes even a revolt are experienced. The third stage, i.e. norming, is a period in which the compactness and cohesion of the team are shaped, some standards, an open exchange of views, mutual support and collaboration appear. It is the beginning of identity feeling. During the stage of performing, constructive attempts to finish tasks are undertaken, and the team members have energy indispensable for efficient work. The last stage includes a formal termination of the activity and a team dissolution. There are different sources of leadership which can cause some resistance from the team members, which is why it is worth analysing the aspects of leadership (Table 2).

Tab. 2. Sources of leadership

Source of leader's impact	Basis of leadership	Engagement	Subordination	Resistance
Relationships with other people	Admiration and liking by other people	PROBABLE, if you believe that the request is important for the leader	POSSIBLE, if the request is perceived as not important to the leader	POSSIBLE, if the request can be disadvantageous for the leader
Expertise	Possession of valuable knowledge and experience	PROBABLE, if the request is formulated as a persuading statement	POSSIBLE, if the request is formulated as a persuading statement, but subordinates have an indifferent relation to the leader's objectives	POSSIBLE, if the leader is arrogant and aggressive and subordinates do not accept the leader's objectives
Position	Position in the professional hierarchy	POSSIBLE, if the request is kind and addressed appropriately	PROBABLE, if the request or order are perceived as legally valid	POSSIBLE, if orders are given in an arrogant way or requests are perceived as inappropriate
Information	Access to important information	POSSIBLE, if the request is supported with appropriate data	PROBABLE, if the request can be justified rationally	POSSIBLE, if the leader behaves in an arrogant, mysterious and manipulating manner
Rewards	Possibility of giving valuable awards	POSSIBLE, if power is used in a subtle, personal manner	PROBABLE, if the partner is not used in a mechanical, impersonal manner	POSSIBLE, if power is used in an arrogant, manipulating manner
Pressure	Possibility of applying punishments	COMPLETELY EXCLUDED	POSSIBLE, if power is used in a kind, friendly manner	PROBABLE, if power is used against people in a manipulating manner

The following forms of the leader's creative impact can be distinguished:

- the authorship – the author develops an innovative project, including its industrial implementation,
- the co-authorship – the co-author elaborates a part of the project or adapts an external project to the required conditions and circumstances,

- the inspiration - the inspirer encourages conducting research, indicates the subject matter or the direction of research, suggests general ideas of innovative character,
- the disposition of resources – the disposer of resources supports and gives finances for research, distributing the financial means according to justified needs of activities which guarantee the project development progress,
- the acceptance – the acceptor assesses proposals and takes decisions about implementation,
- the organisation – the organiser finds and employs personnel capable of generating innovative solutions, ensures an inflow of external ideas, manages a team search for solutions, organises an implementation process and gains the required means,
- the instruction – the instructor facilitates the development of subordinates by an appropriate division of tasks, increases innovative skills of subordinates and solves conflict situations.

Presenting different aspects of improving managerial skills and the ability to solve conflicts should be highlighted. The theory of decisions, the theory of motivation, the theory of gains and the theory of needs lead to the theory of social conflicts, which can be solved due to the theory of negotiations, which is presented in Fig. 11.

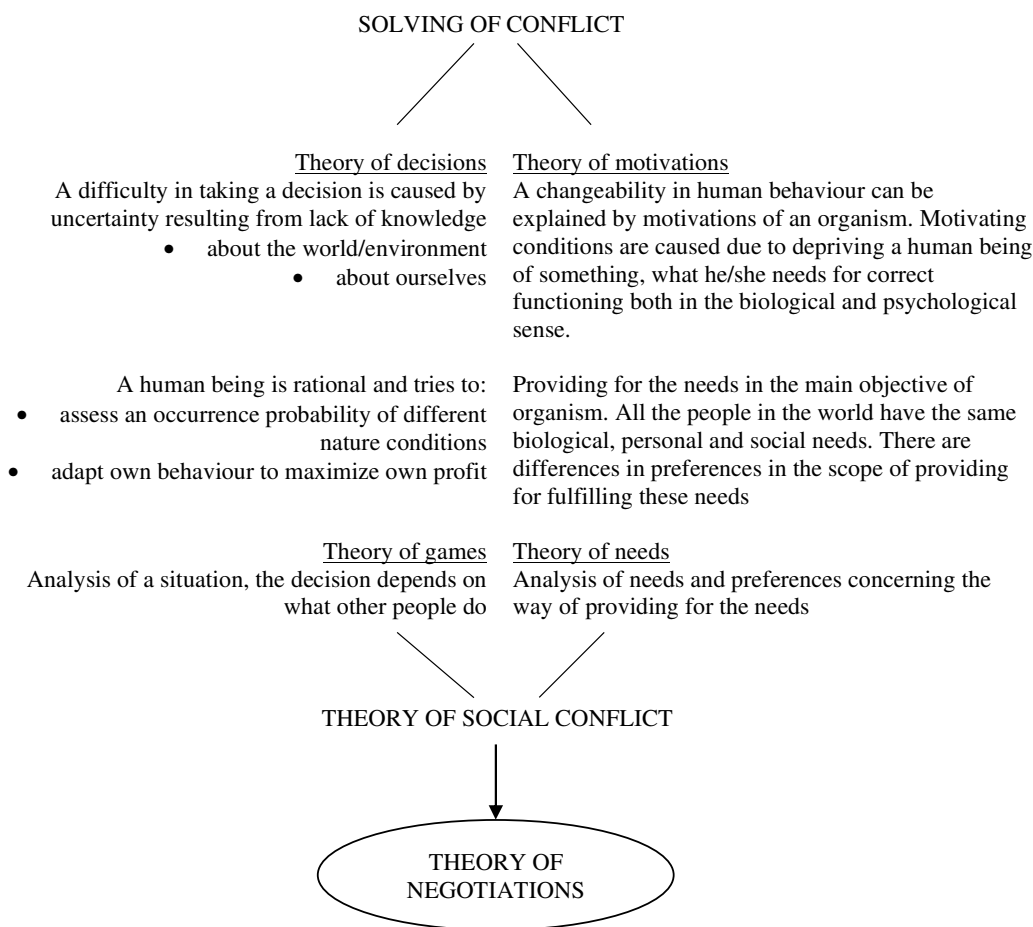


Fig. 11. Different theories of solving conflicts during a project realisation (Authors')

A social conflict occurs when two or more persons have an impression that the aspirations of one of them are in contradiction with a realisation of other people's aspirations, and they are oriented to solving this contradiction. The contradiction means that a process of realising an aspiration (providing for needs) by one of the parties seems to draw unjustified costs for the other one. Aspirations express the interest of parties and their view on how to satisfy these aspirations. Aspirations have their sources in people's creative imagination, in their knowledge about what can be achieved, recognised standards and values, and social relationships. There are different forms of taking decisions. These advantages and disadvantages are presented in Table 3.

Table 3. Forms of taking decisions – advantages and disadvantages

Method of taking decision	Disadvantages	Advantages
Leader's decision without any discussions	<ul style="list-style-type: none"> <li>• One person is not a good source of all decisions.</li> <li>• Advantages of group interactions are wasted.</li> <li>• Lack of obligation to implement the decision by the majority of the team members; a disappointment can have a negative effect on the team efficiency.</li> <li>• Possibilities of other team members are not used.</li> </ul>	<ul style="list-style-type: none"> <li>• This method can be mainly used in the scope of administrative needs.</li> <li>• It is useful in the case of simple routine decisions.</li> <li>• It should be used when there is little time for making a decision when the team members expect the leader to make the decision because they do not have sufficient information or skills to make their own decisions.</li> </ul>
Expert's decisions	<ul style="list-style-type: none"> <li>• It is not always possible to be absolutely sure who is the right expert.</li> <li>• The expert has no responsibility for a decision implementation.</li> <li>• Possibilities resulting from team interaction are lost.</li> <li>• Bitterness may have a negative impact on team efficiency.</li> <li>• Possibilities of other team members are not used.</li> </ul>	<ul style="list-style-type: none"> <li>• This method can be applied when the experience and knowledge of one person significantly exceed the experience and knowledge of other team members, and a discussion will not give any added value.</li> <li>• It should be applied when an engagement of participants in a decision realisation is minor.</li> <li>• Such a decision saves time.</li> </ul>
Average opinion of team members	<ul style="list-style-type: none"> <li>• There is an insufficient interaction among team members, so they cannot learn from one another and take advantage of team discussion.</li> <li>• An obligation to implement a decision is not created.</li> <li>• Unsolved conflicts and disputes may have a negative impact on the team efficiency in future.</li> </ul>	<p>This method should be applied</p> <ul style="list-style-type: none"> <li>- when it is difficult to gather team members for a discussion,</li> <li>- when the decision is so urgent that there is no time for a team decision,</li> <li>- when team members are not obligated to implement the decision,</li> <li>- when team members do not have the skills or information to make a decision in a different way.</li> </ul>
Decision made by the leader after a discussion with the team	<ul style="list-style-type: none"> <li>• An obligation for a decision implementation is not developed.</li> <li>• It does not solve disputes and conflicts among team members.</li> <li>• There is a trend to generate situations in which team members compete with one another to impress the leader or tell him/her what they think he/she wants to hear.</li> </ul>	<ul style="list-style-type: none"> <li>• It uses team members' possibilities to a bigger extent than in previous methods.</li> <li>• Some advantages are obtained as the result of team discussions.</li> </ul>
Decision made by majority	<ul style="list-style-type: none"> <li>• Usually, the minority is left behind, and it can have a negative impact on future team efficiency.</li> <li>• Essential possibilities of several team members can be wasted.</li> <li>• Lack of full commitment for a decision implementation.</li> <li>• Some of the advantages resulting from team interaction can be wasted.</li> </ul>	<ul style="list-style-type: none"> <li>• It can be used when there is not sufficient time to reach a consensus or when a decision is not so important that a consensus is indispensable.</li> <li>• When a full obligation of the team for a decision implementation is not needed.</li> <li>• It orientates the discussion on the issues which are not of great importance to the team.</li> </ul>
Decision made by the minority	<ul style="list-style-type: none"> <li>• Possibilities of many team members will be wasted.</li> <li>• There is no common obligation for a decision implementation.</li> <li>• Unsolved discussions and conflicts can have a negative effect on the team efficiency in future.</li> <li>• There are no advantages to team interaction.</li> </ul>	<ul style="list-style-type: none"> <li>• This method can be used <ul style="list-style-type: none"> <li>- when all the participants cannot meet to take decisions,</li> <li>- when the team is under time pressure,</li> <li>- when only a small number of team members have significant experience or skills,</li> <li>- when a common feeling of obligation is not needed for a decision implementation.</li> </ul> </li> <li>• Useful in the case of simple, routine decisions.</li> </ul>
Consensus	<ul style="list-style-type: none"> <li>• It requires quite a lot of time, psychological strength and high skills of team members.</li> <li>• It cannot be used for sudden and urgent matters.</li> </ul>	<ul style="list-style-type: none"> <li>• It creates innovative decisions of high quality.</li> <li>• It maximises the feeling of obligation for a decision implementation by all the team members.</li> <li>• It uses the possibilities of all team members.</li> <li>• Future decision capabilities of the team are strengthened.</li> <li>• It is useful in the case of taking important, complex decisions causing obligations for all the team members.</li> </ul>

At the KOMAG Institute, two methods of taking decisions in the case of management of innovative research projects are most common, i.e. a decision taken by the leader after a discussion with the team and a consensus decision. Other methods are used occasionally as they turned out to be less efficient.

## CONCLUSIONS

The Authors concentrated on the most significant managerial skills having a crucial impact on the successful realisation of innovative projects oriented toward mining machines. However, the drawn conclusions are of more

general character and can be a sort of guidelines to be used by innovative project managers in different fields of knowledge and expertise:

- The project management process seems to be relatively easy theoretically; however, in practical everyday business life, it is very complicated.
- Managerial skills play a significant role in the management processes of innovative projects.
- The toolbox for agile project management should always include the Scrum method, which relies on highly qualified, interdisciplinary development teams and increases transparency in the project management process.
- At the KOMAG Institute of Mining Technology, the classic project management method has been used so far, but the Scrum Method is now increasingly widely used.
- Good knowledge of project management principles enables risk minimisation and efficient project realisation.
- The project management requires diversified knowledge, varied connections as well as financial, material and personal resources, i.e. achievement of the demanded results according to the scheduled work programme and in the framework of the planned budget.
- It is very important to recognise the basic features and abilities of the project leader as indispensable for a successful realisation of the project management process.
- The requirements concerning the project leader's competencies and abilities include management of the project scope, time of realisation, costs, human resources, risks, quality and communication.

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