



DEVELOPMENT AND USEFULNESS OF PLANNING TECHNIQUES AND DECISION-MAKING FOUNDATIONS ON THE EXAMPLE OF CONSTRUCTION ENTERPRISES IN POLAND

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Abstract. Three groups of planning techniques and foundations for decision-making techniques have been identified. Their development tendencies have been indicated, as well as degree of practical usage by Polish construction companies. Two periods: the years 1990 and 2005 have been compared. Data and numbers have been obtained mainly by questionnaires and personal contacts. A relationship between the degree of utilisation of the discussed techniques and the type, size, and legal ownership of a construction company has not been found, in spite of current prosperity trends in the construction sector. A discrepancy between the evaluation of the degree of attractiveness of techniques and methods from the viewpoint of academics and building company managers has been pointed out.

Keywords: construction management, decision techniques, planning tools, Poland.

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1. Introduction

Techniques of planning the construction projects implementation, and techniques of decision-making have been evolved, depending on economic changes and technological progress. Three basic groups of planning and decision-making techniques can be identified:

Group A: foundations (ways) of decision-making include such basics: intuition, personal experience, research and experiments.

Group B are the most recent planning (and designing) techniques, including the development of DATA BASEs and KNOWLEDGE BASEs, as well as 2D-CAD Systems, AI, 3D & 4D Systems, and RFID Systems (c.f.). It is a group of methods which have recently been

developed most dynamically. Obviously, there is a wealth of bibliography describing those methods and their applications (Kano 2005; Kapliński 1997, 2007; Kim *et al.* 2005; Popov *et al.* 2006; Žilinskas, A., Žilinskas, J. 2006).

Group C includes “traditional” (commonly used) techniques: timetables, network methods, mathematical programming under deterministic conditions, simulations, as well as artificial neural networks, evolutionary methods (genetic algorithms), multicriterion optimisation, etc (c. f. Banaitienė *et al.* 2008; Galinienė *et al.* 2006; Kaplinski, Janusz 2006; Kapliński *et al.* 2002; Ustinovichius *et al.* 2007; Turskis 2008; Zavadskas *et al.* 2005, 2008).

The techniques listed in 3 groups overlap, not to mention that they evolve as such. It will be enough to point at the relationship (evolutionary path) between network methods – esograms – cash flow. The path ends at the research (theoretical and practical) on risk management (Juodis, Stalioraitis 2006; Hastak, Shaked 2000; Royer 2000; Skorupka 2007; Skorupka, Hastak, 2006).

The results in the article are based on the author’s own experience (starting as early as 1983 (Kapliński, 1983), and two questionnaires 2000 and 2005, addressed to people involved in construction engineering and construction management in Poland (Kapliński 1983, 2005b). The article has incorporated information presented during research conferences, as well data contained in PhDs and post-doctorate dissertations (Kapliński 2004, 2005a; Kapliński, Zavadskas 2002). All numerical data (statistics and percentages) presented in the article come from the above-mentioned questionnaires, as well as from:

- interviews (conducted during BUDMA International Trade Fair in Poznań),
- information from Wielkopolska Building Chamber (WIB),
- personal contacts.

Conditions of applications and barriers of developments, the methods of indicated 3 groups are discussed. Besides, the first results of investigations from the range of dependences between the utilization degree (and applying degree) of explored methods/techniques and type/size/property of enterprise are presented.

2. Development of decision techniques and planning tools

The foundations of decision-making, mentioned in group A, are illustrated in Fig. 1.

The figure presents the line of universal trend of utilisation of the above-mentioned techniques/basics. Moreover, the line has been compared with lines characteristic of Western Europe and Poland in 1990s and 2005. The comparison shows that in case of the EU line, there is a slight shift (upwards). In case of Poland, a considerable favourable change of the angle is clearly visible. The same change can be seen in Lithuania.

What is the most difficult is to illustrate the development of techniques originating in group B, because the changes are most dynamic there. An attempt of their development is presented in Fig. 2, which right now ought to be supplemented by 4D modelling, and such techniques as Granular Computing, Agent Technology, VR (Virtual Reality) and, of course, a variety of types of WEB-based Project Management Systems, c.f. (Anumba, Ruikar 2002; Ahuj *et al.* 2006; Kaklauskas *et al.* 2005, 2007; Scheer *et al.* 2007; Zavadskas *et al.* 2006). Internet, Intranet, and Extranet are the natural environment for the latter.

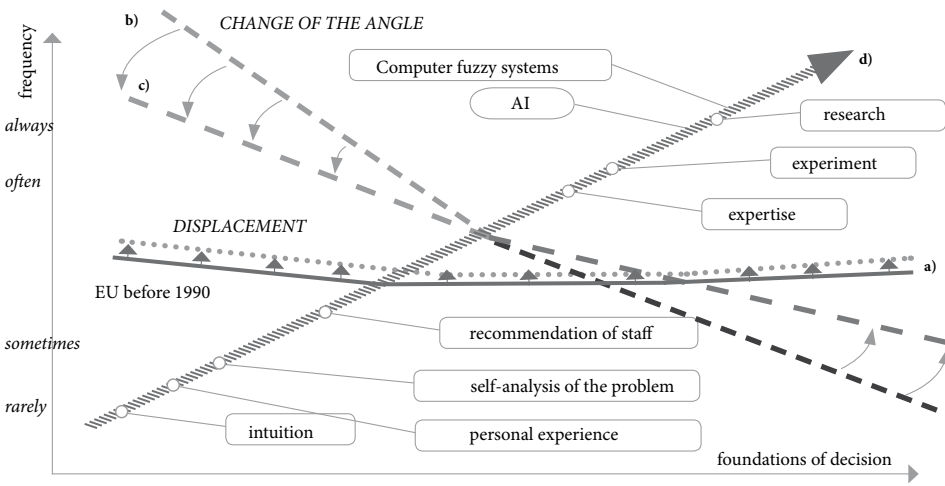


Fig. 1. Change in bases of decision-making: a) for EU before 1990 and in 2005; b) for Poland before 1990; c) Poland in 2005; d) universal trend

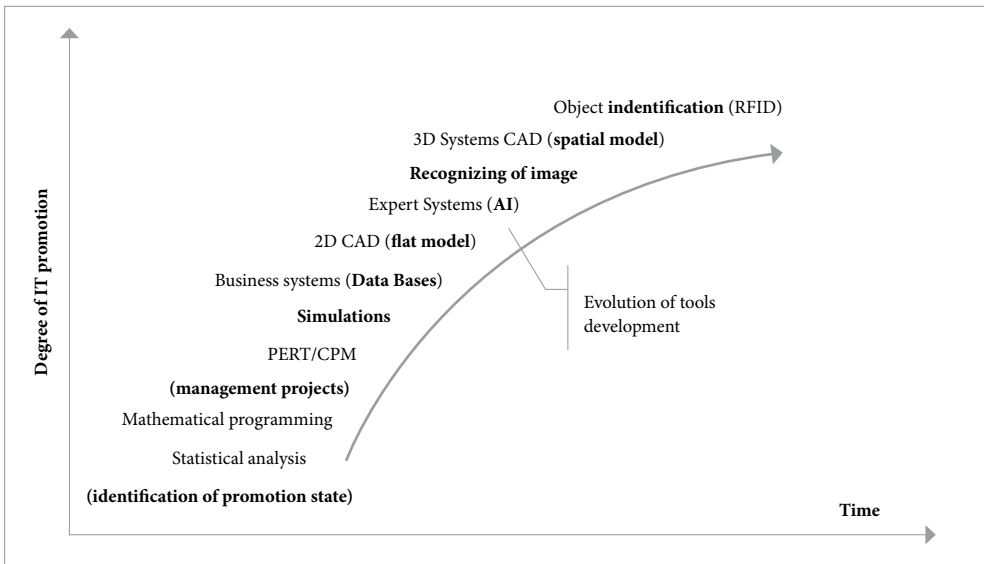


Fig. 2. Evolution of IT tools in the area of construction project management

The development of methods usually reaches a peak, followed by a period of stagnation or death, or a merger with another technique which results in an interesting hybrid. Nonetheless, a new technique can arise, which will replace the old one. It is illustrated by Fig. 3, referring to Decision Support Systems (DSS). It is those systems which gave birth to Advisory

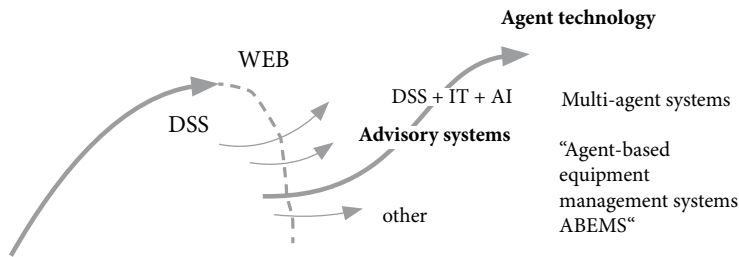


Fig. 3. An example of evolution of DSS

Systems, while a merger of DSS with IT and Artificial Intelligence (AI) helped the formation of Agent Technology (c.f. Nitithamyong, Skibniewski 2004, 2006; Tatari, Skibniewski 2006). There is a wealth of bibliographical sources in this area (Bargiela, Pedrycz 2003; Bubnicki 1993; Jaskowski, Sobotka 2006; Jurkievicius, Laukaitis 2007; Mickaityte *et al.* 2008).

The so-called hybrid approaches are very promising not only as theory, but primarily as a practical solution. Three types of hybrid approaches can be currently identified:

- Combined methods, including simulation-analytical ones (proving efficient in controlling productions), and simulation-heuristic (excellent in research and production reliability assessment).
- Hybrid expert systems (the so-called clean ES have proved to be of little usage in construction industry).
- Hybrid consultation systems (their dynamic development), for example, joining fuzzy data and ANN, especially in technological solutions assessment (e.g., repairs) in building materials selection.

3. Usefulness of planning techniques

The research focused primarily on the degree of utilisation of techniques and methods under discussion in Polish enterprises, which has been concluded to be insufficient. Their usage before 1990 has been compared to 2005 in Table 1. The interest in mathematical programming decreased, similarly to digital simulation. The said degree, regarding expert systems, stayed at its level. There have been increases in: scheduling 4D, WEB-based project management systems and RFID.

Poor research results, presented in Table 1, gave a stimulus to analysing the relationship between the degree of usage of the above-mentioned methods and techniques and type, size, and properties of a building enterprise. Regression and correlation calculation methods have

Table 1. Utilization degree of selected techniques and methods

Techniques/Methods	Degree (%)	
	1900	2005
Mathematical programming	27–50	18
Digital simulation	20	7–15
...
Expert systems	2–5	5
Scheduling 4D (modelling of space + time)	0	5–20
WEB-Based Project Management Systems	0	2–13
RFID (Radio Frequency ID)	0	5–7

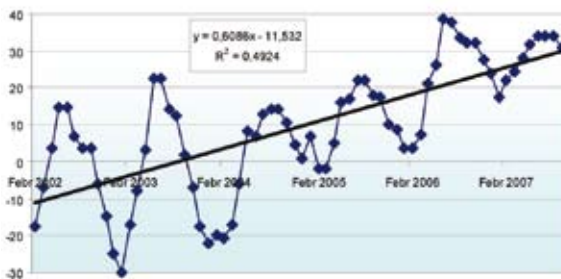
been used. Unfortunately, R^2 coefficient was nearly equal to zero in all cases. The lack of such a relationship proves scarce utilisation of CM tools.

Unimpressive utilisation of those techniques by Polish enterprises can be explained by a limited range of research and too sophisticated questions. Representatives of companies and enterprises are reluctant to answer such type of questions, often hiding behind arguments of commercial secrecy, privacy, and competitiveness.

It all happens, when circumstances for developing CM tools in Poland are favourable: free market, competitiveness and, first of all, favourable PMR-index of economic situation in construction industry. The index can take values between minus 100 and plus 100 and, since 2004, it has been in the range of positive values (+6.6); in 2006 it reached the level of 25.7 points, and in 2007 has been at the same level. Detailed values of the index are presented in Fig. 4 – data have been drawn from (Eurobankier ... 2008).

It means that the situation in the construction industry is viewed as positive. In the first half of 2006, the forecast of 75% of Polish companies was that the situation in the Polish construction sector in the coming 12 months would improve (Fig. 5), while 57% companies planned to increase employment. In this case, 104 enterprises became examined by analytic firm PMR (PMR Publications 2006).

Some changes in priorities of our enterprises are quite clear. A comparison of problems and needs of enterprises in two regions, i.e., Kursk (Russia) and Kujawy-Pomerania (Poland)

**Fig. 4.** Changes in demand index in construction industry

has been shown in Fig. 6. Data and numbers have been drawn from Kovalenko (2005) and Bizognórecka, Górecki (2005). The basic differences are as follows: while Polish enterprises are looking for qualified staff and good managers, the Russian ones are primarily geared towards increasing profit and attracting additional capital.

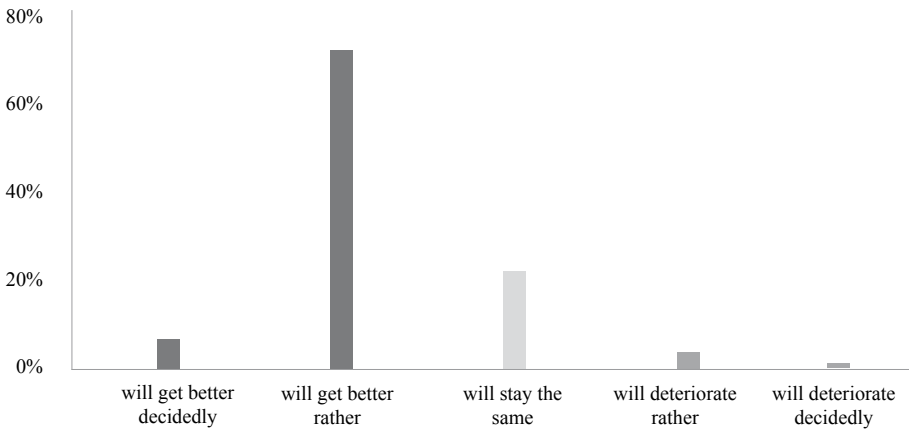


Fig. 5. Demand for construction industry services as seen by building companies

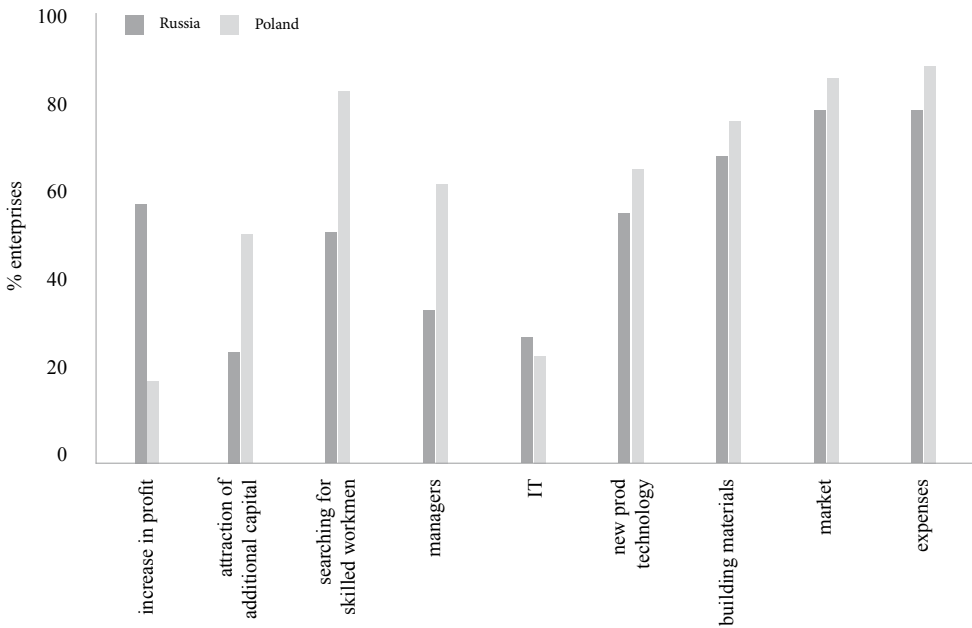


Fig. 6. Comparison of problem areas and needs in Polish and Russian building enterprises

Polish construction companies consistently transform into real estate developers. From the developers' viewpoint, the following are the most important obstacles in company development, including utilisation of adequate planning methods:

- shortage of land available for development,
- changing prices,
- alterations in legal regulations.

The earlier hypothesis may be confirmed by data from the Polish Union of Building Employers. According to the Union’s estimates, the shortage of specialists in construction industry at the end of 2007 was 150 thousand, while at the same time 262 thousand specialists were registered as unemployed. This anomaly negatively interferes with other sectors, for example, planning, and with utilisation of the methods under discussion.

Further observations showed differences in evaluating the „attractiveness” of techniques and methods depicted in 3 groups: A, B, and C. The opinions of academics and research institutes are presented in Fig. 7, while the attractiveness in view of construction companies (Planning Departments) is shown in Fig. 8.

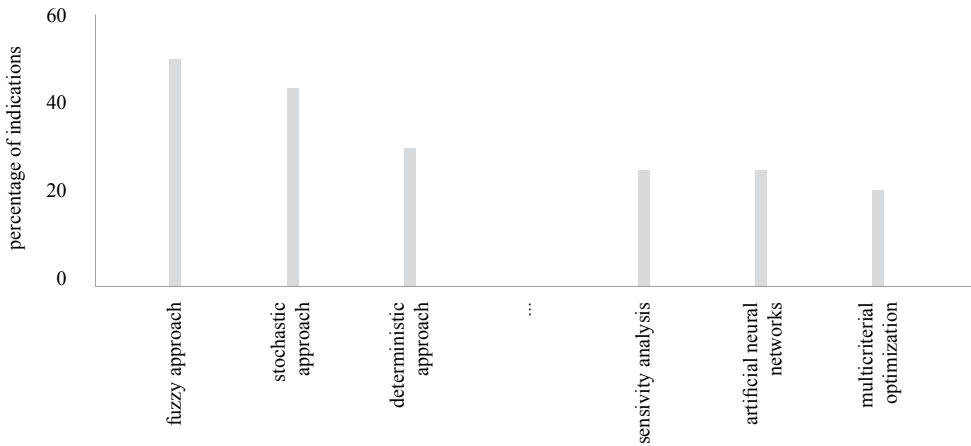


Fig. 7. Attractiveness of techniques and methods from the viewpoint of academic teachers and research institutes

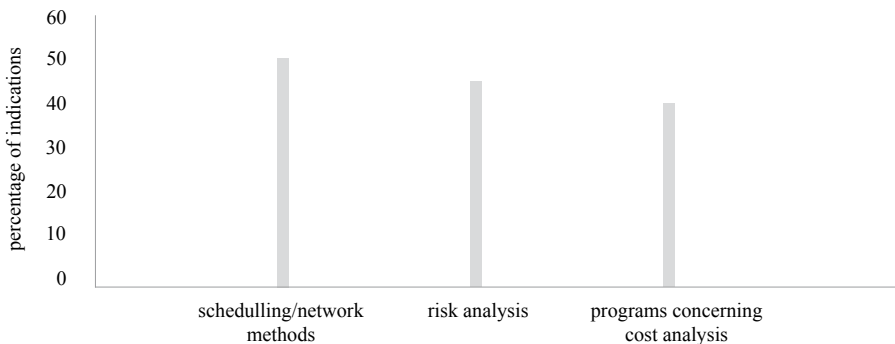


Fig. 8. Attractiveness of techniques and methods from the viewpoint of construction companies' planning departments

Day-to-day problems reported during the investigation were as follows:

- human resources management,
- PPP,
- cash flow.

What it means is that there is an increased interest and need for such programmes as: budgeting, risk management, time and cost contingency, ways of financing investments.

4. Conclusions

Techniques and planning methods in the area of construction projects and decision-making methods develop dynamically. There is a clear dependence on new, sometimes quite sophisticated IT technologies.

The decision to employ techniques categorised into groups A, B, or C is influenced by general economic conditions, and only marginally by competition. Polish companies struggle for survival, but financial liquidity seems to be a crucial factor for survival.

What is quite clear is the tendency to unify the ways of decision-making to do it comparable to the EU. Polish construction companies tend to borrow planning and decision-making techniques from the electrical, heavy machinery, and telecommunications sectors more often now than they used to in the past.

Managers in construction sector have high hopes not only for RFID (Radio Frequency ID), but also in GIS (*Geographic Information System*), but merged with GPS (*Global Positioning System*) navigation. Using them jointly may produce an interesting effect in monitoring and controlling production in construction industry.

References

- Ahuj, A. V.; Yang, J.; Shankar, R. 2006. *WEB based communication for construction project management*. Available from Internet: <<http://eprints.qut.edu.au>> (Dec. 2006).
- Anumba, C. J.; Ruikar, K. 2002. Electronic commerce in construction – trends and prospects, *Automation in Construction* 11(3): 265–275.
- Banaitienė, N.; Banaitis, A.; Kaklauskas, A.; Zavadskas, E. K. 2008. Evaluating the life cycle of a building: a multivariant and multiple criteria approach, *Omega-International Journal of Management Science* 36(3): 429–441.
- Bargiela, A.; Pedrycz, W. 2003. *Granular computing. An introduction*. Kluwer Academic Publishers. The Kluwer International Series in Engineering and Computer Science, Vol 717. Norwell/Hingham.
- Bizognórecka, J.; Górecki, J. 2005. Risk management in the Polish enterprises – effects of research, in Bizon-Górecka, J. (Ed.). *Strategies of risk management in the enterprise*. TNIOK, Bydgoszcz – Ciechocinek, 101–110 (in Polish).
- Bubnicki, Z. 1993. *Foundations of computer systems in management*. Wyd. Politechniki Wrocławskiej, Wrocław (in Polish).
- Eurobankier. PL Available from Internet: <<http://euro.bankier.pl> (~koniunktura w budownictwie, Polska)>, source: GUS (accessed 2008-03-05, in Polish).
- Galiniienė, B.; Marčinskas, A.; Malevskienė, S. 2006. The cycles of real estate market in the Baltic countries, *Technological and Economic Development of Economy* 12(2): 161–167 (in Lithuanian).

- Hastak, M.; Shaked, A. 2000. ICRAM: Model for international construction risk management, *Journal of Management in Engineering*, ASCE 16(1): 59–69.
- Jaskowski, P.; Sobotka, A. 2006. Scheduling construction projects using evolutionary algorithm, *Journal of Construction Engineering and Management*, ASCE 132(8): 861–870.
- Juodis, A.; Stalioraitis, P. 2006. The analysis of statistical characteristics of construction cost, *Foundations of Civil and Environmental Engineering* (8): 59–71.
- Jurkiewicz, D.; Laukaitis, A. 2007. Application of the program AGENT, that uses reality ontology, as data source for the decision-support system, *Technological and Economic Development of Economy* 13(3): 237–243 (in Lithuanian).
- Kaklauskas, A.; Zavadskas, E. K.; Trinkūnas, V. 2007. A multiple criteria decision-support on-line system for construction, *Engineering Application of Artificial Intelligence* 20(2): 127–194.
- Kaklauskas, A.; Zavadskas, E.; Andruškevičius, A. 2005. Cooperative integrated web-based negotiation and decision-support system for real estate, in *CDVE 2005, Lecture Notes in Computer Science* 3675: 235–242.
- Kano, N. 2005. New construction management tools: 3D-CAD, virtual reality, RFID technologies at construction sites, in *Proc. 1st ICCEM 2005*, Seoul, Korea, CD, 103–132.
- Kapliński, O. (ed.). 2007. *Methods and models of research in construction project engineering*. Warsaw, PAN, IPPT.
- Kapliński, O.; Janusz, L. 2006. The phases of multifactor modelling of construction processes, *Journal of Civil Engineering and Management* 12(2): 127–134.
- Kapliński, O. 2005a. Modelling construction processes: a review of research and dissertations at the Poznań University of Technology, *Civil and Environmental Engineering Reports* (1): 85–105.
- Kapliński, O. 2005b. The section of construction management (Inquiry 2000–2005), *Paper presented at Civil Engineering Committee of Polish Academy of Science in Zielona Góra University*, June 15, slides: 58.
- Kapliński, O. 2004. Section of Construction Management in Civil Engineering Committee of Polish Academy of Science: the retrospection and the nearest term, in *Proc. of Conference on Management of Investment Processes in the Building*, Krakow University of Technology, Kraków, May 13–15, 55–77.
- Kapliński, O.; Werner, W.; Kosecki, A.; Biernacki, J.; Kuczmarski, F. 2002. Current state and perspectives of research on construction management and mechanization in Poland, *Journal of Civil Engineering and Management* 8(4): 221–230.
- Kapliński, O.; Zavadskas, E. K. 2002. An overview of problems related to the research in construction engineering, management and economics in Poland, *Journal of Civil Engineering and Management* 8(4): 231–239.
- Kapliński, O. 1997. *Modelling of construction processes. A managerial approach*. Warszawa, PAN, IPPT.
- Kapliński, O. 1983. Conditions of the development and utilization of decision techniques in the building enterprise on the background of the new conditions of economy, *Zeszyty Naukowe Politechniki Poznańskiej, Organizacja* 13: 253–300 (in Polish).
- Kim, Y.-T.; Hyun, C.-T.; Koo, K.-J. 2005. Development of strategies for applications of 4D modeling in construction management, in *Proc. 1st ICCEM 2005*, Seoul, CD, 1181–1186.
- Kovalenko, V. 2005. Risks in management of industrial enterprises in conditions of globalization of Russian economy, in Bizongorecka, J. (ed.). *Strategies of Risk Management in the Enterprise*. TNIOK, Bydgoszcz – Ciechocinek, 145–150.
- Mickaitytė, A.; Zavadskas, E. K.; Kaklauskas, A.; Tupėnaitė, L. 2008. The concept model of sustainable buildings refurbishment, *International Journal of Strategic Property Management* 12(1): 53–68.
- Nitithamyong, P.; Skibniewski, M. J. 2006. Success/failure factors and performance measures of Web-based construction project management systems: Professionals' viewpoint, *Journal of Construction Engineering and Management* 132(1): 80–87.

- Nitithamyong, P.; Skibniewski, M.J. 2004. Web-based construction project management systems: how to make them successful? *Automation in Construction* 13(1): 491–506.
- PMR Publications. 2006. Market analysis in Central and Eastern Europe. Available from Internet: <<http://www.pmrpublications.com>> (accessed 200611-06, in Polish).
- Popov, V.; Mikalauskas, S.; Migilinskas, D.; Vainiūnas, P. 2006. Complex usage of 4D information modelling concept for building design, estimation, scheduling and determination of effective variant, *Technological and Economic Development of Economy* 12(2): 91–98.
- Royer, P. S. 2000. Risk management: the undiscovered dimension of project management, *Project Management Journal* 31(1): 6–13.
- Scheer, S.; Mendes, R. Jr.; Quevedo, J. R. S.; Mikado, J. Jr.; Fontoura, P. S. 2007. *The necessary background for implementing and managing building design process using WEB environments*. Available from Internet: March at <<http://itcon.org/2007/15/>>.
- Skorupka, D. 2007. *The method of identification and risk assessment of construction project realization*. Warsaw WAT (in Polish).
- Skorupka, D.; Hastak, M. 2006. Identification and analysis of risk indicators of an increase in construction project costs, *Science Journal of Gdansk University of Technology, Series Civil Engineering (Proc. of Conference Krynica 2006)*, Gdansk, 223–230.
- Ustinovichius, L.; Zavadskas, E. K.; Podvezko, V. 2007. Application of a quantitative multiple criteria decision-making (MCDM-1) approach to the analysis of investments in construction, *Control and Cybernetics* 36(1): 251–268.
- Tatari, O.; Skibniewski, M. 2006. Integrated agent-based construction equipment management: conceptual design, *Journal of Civil Engineering and Management* 12(3): 231–236.
- Turskis, Z. 2008. Multi-attribute contractor ranking method by applying ordering of feasible alternatives of solutions in terms of preferability techniques, *Technological and Economic Development of Economy* 14(2): 224–239.
- Zavadskas, E. K.; Kaklauskas, A.; Turskis, Z.; Tamošaitienė, J. 2008. Selection of the effective dwelling house walls by applying attribute values determined at intervals, *Journal of Civil Engineering and Management* 14(2): 85–93.
- Zavadskas, E.; Kaklauskas, A.; Vainiūnas, P.; Dubakienė, R.; Gulbinas, A.; Krutinis, M.; Čygas, P.; Rimkus, L. 2006. A building's refurbishment knowledge and device-based decision support system, in *CDVE 2006, Lecture Notes in Computer Science* 4101: 287–294.
- Zavadskas, E.; Kaklauskas, A.; Andruškevičius, A.; Vainiūnas, P.; Banaitienė, N. 2005. Model for an integrated analysis of a building's life cycle, in *CDVE 2005, Lecture Notes in Computer Science* 3675: 218–226.
- Žilinskas, A.; Žilinskas, J. 2006. On visualization of multidimensional data using three-dimensional embedding space, *Technological and Economic Development of Economy* 12(4): 353–359.

**PLANAVIMO METODAI IR SPRENDIMŲ PRIĖMIMO PAGRINDAI LENKIJOS
STATYBOS ĮMONĖSE: NAUDINGUMAS IR TOBULINIMAS****O. Kaplinski****Santrauka**

Identifikuotos trys planavimo metodų ir sprendimų priėmimo pagrindų grupės. Nustatytos jų tobulinimo kryptys ir praktinis pritaikymas Lenkijos statybos įmonėse. Palyginti du periodai – 1990 ir 2005 metai. Duomenys surinkti organizuojant apklausas ir naudojantis asmeniniais kontaktais. Nenustatytas ryšys tarp minėtų priemonių naudojimo intensyvumo ir įmonių tipo, dydžio bei teisinio statuso nepaisant dabartinio statybų verslo klestėjimo. Pastebėtas akademinės visuomenės ir statybos kompanijų vadovų nuomonių nesutapimas planavimo priemonių naudojimo ir patrauklumo klausimais.

Reikšminiai žodžiai: statybos vadyba, sprendimų priėmimo technika, planavimo priemonės, Lenkija.

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