



HISTORY AND EVOLVING TRENDS OF CONSTRUCTION COLLOQUIA ON SUSTAINABILITY AND OPERATIONAL RESEARCH

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Abstract. The article presents development and trends of international cooperation between three academic centers from Germany, Poland and Lithuania. The review of results of 11 conferences have been presented: exchange of experience (1986–2008), integration of academic community, support for promotional works constitute goals of these meetings. Decision-making methods, multi-criteria optimization and sustainability were the subject of the cooperation. All eleven colloquiums were organized by the same researchers and there were published tens of books and more than 350 scientific articles related to the mentioned colloquia. The most important scientific trends and the results achieved are examined in the paper.

Keywords: construction, sustainability, multiple criteria methods, operational research, international collaboration, results.

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1. The development of meetings

During the period of Lithuania's incorporation into the Soviet Union, scientific cooperation with foreign higher education institutions was lying dormant practically in the state of lethargy. It was regulated from Moscow. A closer cooperation among individual scientists and research groups could only be established in the cases when some lucky ones managed to get a chance of going abroad to work on probation for a longer period of time.

On the initiative of Prof. A. Čyras, the former principal of the Vilnius Civil Engineering Institute, the author of this article in 1980–81 worked on probation in the Leipzig Higher

Technical School. During this period the School was managed by its former principal Prof. K. Fiedler.

The cooperation did not cease after the probation. Close relations have been established with Dr Friedel Peldschus, a lecturer of the School.

In 1986 joint research work was prepared and issued by a publishing house of the School (Fiedler *et al.* 1986). This work provided the basis for arranging a scientific colloquium with the participation of representatives of higher schools and construction enterprises of the Democratic Republic of Germany. All the three co-authors of the publication read their respective reports at the colloquium.

In 1989 a decision was made to arrange the second colloquium with the invitation of representatives from Poland. Professors K. Fiedler, J. Ester, O. Kapliński, Ch. Wagner participated in the colloquium.

The third colloquium, 1991, took place in Vilnius in the premises of the Civil Engineering Institute that had already been reorganized into the Vilnius Technical University (VTU). The event took place in the independent Lithuania. Among participants there were scientists of the already reunited Germany represented by three higher schools – Leipzig Higher Technical School, Rhein-Westphalia Higher Technical School (RWTH-Aachen) and Weimar Higher School of Architecture and Engineering. There were also representatives of the Poznan University of Technology (PUT) invited who had already participated in the second colloquium. Representatives of Moscow and Leningrad Civil Engineering Institutes (now renamed in Technical Universities) and Bratislava Technical University (BTU) sent their reports to the colloquium. A report was also sent by representatives of the Danish Aalborg University. There was a large number of scientists participating on behalf of the hosting Vilnius Technical University.

Organizers of the fourth colloquium were a group of scientists from Poznan Technical University directed by Prof. O. Kapliński. The colloquium took place in 1993 with the participation of researchers from Germany, Poland and Lithuania. A report was also received from scientists of the Bratislava Technical University.

The initiative of organizing the fifth colloquium in 1995 belonged to Prof. F. Peldschus – Chancellor of the Leipzig Higher Technical, Economic and Cultural School (HTWK) and his team of scientists. This time the VTU had 9 representations. German representatives included Prof. F. Peldschus and Prof. R. Seeling. Among participants there were also representatives of the Poznan Technical University, although they did not present reports for publishing.

The sixth joint Lithuanian-German-Polish colloquium took place in the Vilnius Technical University, Lithuania. Reports were read by scientists from Leipzig Prof. F. Peldschus, Prof. S. Raeder, Prof. H. Mueller, representatives of the Poznan Technical University Prof. O. Kapliński and others as well as scientists of the VTU.

The organizer of the seventh colloquium in 1999 was Prof. R. Seeling from the RWTH – Aachen. Large groups of scientists from Poland and Lithuania, three Professors from Leipzig and several researchers from Aachen. Representatives of the Leipzig Higher Technical, Economic and Cultural School took the initiative of publishing the research works of the colloquium. The publication was issued in 2000. Not all the reports have been published due to the lack of space. Therefore, the Vilnius Gediminas Technical University (former VTU)

alongside commemorating the 15th anniversary of co-operation between the interrelated departments of the VGTU and Poznan TU, decided to issue a special-purposed edition of the "Civil Engineering" journal and to publish therein reports of other authors, including articles covering research work results achieved by groups of scientists of the VGTU and Poznan TU during the period between the last two colloquiums.

The 2001 colloquium took place in Vilnius and it was the eighth colloquium over the period of 15 years that witnessed such political events as the downfall of the Soviet Union, restoration of Lithuania's independence, reunification of the Democratic Republic of Germany and Federal Republic of Germany, accession of Poland to NATO and splitting of Czechoslovakia into two independent states, Czech Republic and Slovakia.

The Vilnius Civil Engineering Institute, headed by the author of this article Zavadskas, saw the reorganization of the Institute into the Vilnius Technical University (VTU) in 1990. On 17 October 1996, the Lithuanian Parliament (Seimas) granted the name of Lithuanian Great Duke Gediminas to the University, thus renaming it into the Vilnius Gediminas Technical University (VGTU).

The 9th colloquium took place in Kolobrzeg 2003 and has been organized by Poznan University of Technology. Development of decision-making support systems was the dominating theme. Additionally, verbal decision methods, e-business systems, risk in property valuation methods, investment process in construction were presented. The presentations of this colloquium were published in a special issue (Rakowski, Kapliński 2004).

The 10th Colloquium took place in Leipzig 2005 and has been organized by Leipzig University of Applied Science "Modern instruments in Management". The colloquium was organized into sections: "Construction Economics and Rationalization", "New Educational Methods", "Multi-criteria Decisions in Civil Engineering", "Facility Management", "Construction Processes". The presentations of this Colloquium were published in a special issues (Kaklauskas *et al.* 2005; Peldschus 2006, Peldschus *et al.* 2006; Zavadskas, Kaklauskas 2008a; Brauers, Zavadskas 2007).

The last 11th Colloquium took place in Kolobrzeg 2007 and has been organized by Poznan University of Technology (Division of Construction Engineering and Construction Management, Institute of Structural Engineering). Development and decision-making support systems was the dominating theme. The articles of this colloquium are published in this issue of journal (Kapliński 2008b).

The colloquiums have been held on a regular basis. Participants cooperated, read reports, published articles, defended theses, participated themselves and invited others to participate in the theses defending procedures.

2. Achievements of colloquiums

The participants of the colloquiums started to publish 5 journals. Zavadskas is the Editor-in-Chief of "Statyba – Civil Engineering" (since 2002 – "Journal of Civil Engineering and Management", ISSN 1392-3730) and "Technological and Economic Development of Economy" (ISSN 1392-8619). Editors Zavadskas and Kaklauskas started to publish "International Journal

of Strategic Property Management” (ISSN 1648-715X). Ginevičius is the Editor-in-Chief of “Journal of Business Economics and Management” (ISSN 1611-1699) and “Business: Theory and Practice” (ISSN 1648-0627).

The participants of the colloquiums published many articles in mentioned and other journals. This article presents the survey of articles by colloquium participants published in special issues of mentioned and other journals in 2006–2008 (Zavadskas, Burinskienė 2007, Brauers, Zavadskas 2007; Pakalnis *et al.* 2007; Zavadskas, Kaklauskas 2008a). The articles of the 10th Colloquium published by Kaklauskas *et al.* (2005) and Peldschus *et al.* (2006) are not analyzed here.

In the articles written by Zavadskas, Kaklauskas (2001), Kaplinski *et al.* (2004), Kaklauskas *et al.* (2005) and Peldschus *et al.* (2006), a brief summary is given of the research results achieved by the colloquium participants. These are reports delivered during the period of 20 years. Not all articles have been published in the press, although the majority of them have been issued. The article analyzes only the colloquium material published in research journals. Besides, efforts have been made to gather information on Habilitations (Post-doctoral Dissertation) and Doctoral theses defended by the colloquium participants as well as their science books on the colloquium issues. Although we can hardly say that every possible piece of information has been found, nevertheless the bibliographical materials we managed to collect is quite copious and worth summarizing and publishing. Publication of the collected data will facilitate the work of other authors interested in problems related to decision-making in the sphere of civil engineering.

19 Professors or Doctors Habil (Post-Doctoral Dissertation) have participated in the work of the colloquiums, 10 of them in 1986–2006 defended Habilitations: F. Peldschus (1986, Leipzig), E. Zavadskas (1987, Moscow), R. Ginevičius (1997, Vilnius), A. Kaklauskas (1999, Vilnius), L. Ustinovič (2003, Vilnius), S. Raslanas (2005, Vilnius), V. Podvezko (2006a, Vilnius). 50 Doctors of science or Associate Professors have taken part in the colloquiums. Among other participants are research fellows, assistants or persons maintaining Doctoral theses.

Table 1 provides information about the number of colloquium participants, their theses defended and books written.

Table 1. Number of participants, books, defended Habilitations (Dr Sc) and Doctoral theses

	Total	Country						
		Lithuania	Germany	Poland	Russia	Czech	Denmark	Estonia
Number of participants	74	29	21	14	5	3	1	1
Number of books	39	23	7	4	3	–	2	–
Habilitation or Dr Sc. theses defended	11	7	1	–	3	–	–	–
Doctoral theses defended	48	29	4	7	6	–	2	–

As one can see, quite a lot of books have been compiled by international groups of scientists. In Leningrad a study guide has been published (Badjin *et al.* 1989). In Leningrad the monograph of Zavadskas (Завадскас 1991) and in Denmark the book of Zavadskas *et al.* (1992) as well as the book prepared by authors together with Dane Bejder. Vilnius saw the publication of the monograph prepared by Zavadskas *et al.* (1994) followed by the monograph of Zavadskas, Kaplinski, Kaklauskas and Brzezinski issued next year (Zavadskas *et al.* 1995). In Vilnius the monograph “Matrix Games in Building Technology and Management” by Peldschus and Zavadskas (1997) has been published. In 2000 Zavadskas monograph “Mehrkriterielle Entscheidungen im Bauwesen” was published in Vilnius (Zavadskas 2000), which was edited and prefaced by Peldschus and in Germany was published the books of Zavadskas, Kaklauskas (2007) and Ginevičius *et al.* (2005, 2006a). Kaplinski (1997, 2007) in the books issued by the Polish Academy of Sciences reviews research works of the majority of colloquia participants.

Colloquium participants discussed a wide range of rational decision-making problems within the field of construction technology, management and sustainable development.

2.1. Creation of decision-support systems intended for designing rational technological processes

The participants of Colloquiums have created the above-mentioned decision-support systems:

- A building’s refurbishment knowledge and device-based decision-support systems (Zavadskas *et al.* 2006a, 2008b, c; Kaklauskas *et al.* 2006c, 2007a, 2008; Mickaitytė *et al.* 2007, 2008).
- An intelligent tutoring system for construction and real estate management, Master’s degree studies (Kaklauskas *et al.* 2006a, b, 2007a, b).
- A multiple criteria decision-support on-line system for construction (Kaklauskas *et al.* 2007c).
- Web-based intelligent DSS for real estate (Zavadskas *et al.* 2008a).
- Highway noise management using advisory system (Paslowski 2008).
- Decision-support system for innovation with a special emphasis on pollution (Kaklauskas, Zavadskas 2007; Zavadskas *et al.* 2007a).
- DSS for the multivariant design and multiple criteria analysis of the life cycle of buildings (Banaitienė *et al.* 2008).
- Multi-variant decision-support e-system for device and knowledge-based intelligent residential environment (Naimavičienė *et al.* 2007).

2.2. Creation, improvement and application of the multiple criteria decision-making methods

Peldschus *et al.* has carried out a lot of scientific research with aim-adapting methods of the game theory for solving construction technology and organization tasks (Peldschus

2007a, b; Antuchevičienė *et al.* 2006; Podvezko 2008a; Turskis *et al.* 2006; Meszek 2007, 2008; Zavadskas *et al.* 2008d; Ginevičius, Krivka 2008).

Zavadskas and Antuchevičienė have applied the fuzzy set theory for the search of rational solutions in redevelopment of derelict buildings construction (Zavadskas, Antuchevičienė 2006, 2007; Antuchevičienė, Zavadskas 2008).

An authors' group has applied the whole set of multiple criteria optimization methods for solving various construction technology and other problems (Ginevičius *et al.* 2007, 2008; Ginevičius 2006, 2007, 2008; Ginevičius, Podvezko 2008a, b; Peldschus 2008; Ustinovichius *et al.* 2007; Ustinovichius 2007b; Turskis 2008; Kapliński, Janusz 2006; Kalibatas *et al.* 2007; Zavadskas *et al.* 2006b, 2007b, 2008d; Sivilevičius *et al.* 2008).

New methods for performing multiple criteria analysis of the project have been developed by an authors' group: a method of complex determination of the significances of the criteria taking into account their quantitative and qualitative characteristics (COPRAS) and applying attributes values determined in intervals COPRAS-G (Zavadskas *et al.* 2008b); a method of multi-objective optimization on the basis of Ratio Analysis – MOORA (Brauers and Zavadskas 2006).

COPRAS method was used for multi-attribute assessment of road design solutions (Zavadskas *et al.* 2007b), for evaluating the sustainability of Vilnius-city residential areas (Viteikienė 2006; Viteikienė and Zavadskas 2007).

MOORA method was used for multi-objective decision-making in road design (Brauers *et al.* 2008) and others (Brauers *et al.* 2007; Kalibatas, Turskis 2008).

An authors' group has applied the whole set of multiple criteria optimization methods for modelling of facilities management alternatives (Lepkova *et al.* 2008; Malienė *et al.* 2008; Reichelt *et al.* 2008; Thiel 2008; Liias 2007; Paadam, Liias 2008; Otto 2008).

Problems related to the application of expert methods. Research works of Ginevičius, Podvezko (2007a, b), Podvezko (2006b, 2007), Turskis *et al.* (2006), Teixeira *et al.* (2006) are intended to improve the expert investigation methods.

2.3. Issues of the construction process harmonization and reliability

The largest amount of works have been done in this sphere by a group of scientists headed by Kaplinski, Ustinovichius and Vaidogas. Scientists from Lithuania, Germany and Poland presented their reports on these issues (Kaplinski 2008a; Podvezko 2006b; Ustinovichius *et al.* 2006a, b, 2007a, b; Shevchenko *et al.* 2008; Ustinovichius, Kochin 2008). Introducing reliability measures into multi-criteria decision-making are presented in the articles of Vaidogas, Zavadskas (2007) and Vaidogas *et al.* (2007).

2.4. Issues of complex assessment of sustainable development

Ginevičius and Podvezko (2007a, 2008b) used methods for complex assessment of sustainable development of state regions with an emphasis on ecological and dwelling conditions. Ginevičius *et al.* (2006) and Brauers *et al.* (2007) applied method for complex evaluation of economic development of the Baltic States and Poland.

An authors' group used new method for sustainable development assessment of cities and their residential districts (Carassus *et al.* 2006; Šaparauskas, Turskis 2006; Zagorskas, Turskis 2006; Zagorskas *et al.* 2007).

Research group developed methods for analyzing investment problems (Schach, Naumann 2007; Mitkus 2008; Mitkus, Šostak 2008; Mitkus, Trinkūnienė 2006; 2007, 2008; Shevchenko *et al.* 2008).

2.5. Modelling and forecasting construction in Lithuania

The research aim was to produce an analytical model of the rational construction industry in Lithuania by undertaking a complex analysis of micro-, meso- and macro-environment factors affecting it and to give recommendations on the increase of its competitive ability (Banaitis, Banaitienė 2007; Banaitienė, Banaitis 2006; Bejder *et al.* 2008; Ginevičius, Podvezko 2008b; Zavadskas, Kaklauskas 2008b). The research was performed by studying the expertise of advanced industrial economics and by adapting it to Lithuania, taking into consideration a specific history, development level, needs and traditions. Simulation was undertaken to provide insight into creating an effect (Ambrasas, Stankevičius 2007; Raslanas *et al.* 2006; Yetgin, Lepkova 2007) and for defining the utility and market value of a real estate, a multiple criteria approach (Kaklauskas *et al.* 2007d; Meszek 2008).

3. Other aspects of the cooperation

The colloquia have been held on a regular basis. During these meetings the following problems have been discussed (Kapliński *et al.* 2004):

- presentation of the teams engaged in: education, lectures and exercises, professional activity, research theses,
- the discussion on the most important events and publications published during last two years,
- presentation of current PhD theses and post-doctoral dissertations (Habitations),
- synthesis of research.

Participants cooperated, read reports, published articles, defended theses, participated themselves and invited others to participate in the theses defending procedures.

The following 6 monographs are examples of synthesis work of papers presented during colloquia and involving scientific cooperation: the synthesis from the field of construction process modelling (Kapliński 1997, 2007) and from the field of multicriteria decision-making methods (Zavadskas 2000; Zavadskas, Kaklauskas 2007; Zavadskas *et al.* 1994).

From the historic point of view, the first work in which authors presented the synthesis of decision-making problems in construction management were the following items: Fiedler *et al.* (1986) and Kapliński (1992).

The first work in which authors presented synthesis from the field of game theory in construction management were Peldschus and Zavadskas (1997).

This form of cooperation and the resulting success have been highly appraised by Senates of Universities as well as by the international foundation – in the name of Adam Mickiewicz – established by the presidents of Lithuania and Poland. The prestigious Lithuanian monthly “Kultūros barai”, Polish quarterly “Lithuania” journals highly regarded this cooperation as well. This was the reason that the invited leaders of the colloquia became participants of the conference on “Humanization of Technology” under the patronage of the President of Lithuania Valdas Adamkus and were awarded by medal “Integral humanism”.

Prof. F. Peldschus was conferred the title of Doctor honoris causa of Vilnius Technical University in 1991, Prof. O. Kapliński was honoured by Vilnius Gediminas Technical University in 1996. In 2002 at Poznan University of Technology Prof. E. Zavadskas expressed the needs of the international cooperation between universities according to the spirit of integral humanism. He made these remarks at the ceremony of granting the title of Doctor honoris causa.

There is a group of participants of our colloquia, who are members of the European Working Group of Multi-Criteria Decision Aiding.

As a result of participants of our colloquia, an international working group concerning Decision-Making in Civil Engineering and in Sustainable Development has been created. This group will be a part of the European Association of Operational Research (EAOR).

4. Conclusions

The following conclusions about the general character of the cooperation can be drawn:

1. Results of the cooperation are impressive.
2. Across-the-border cooperation between academic centres is spectacular and has been highly appraised.
3. Further cooperation in the area of Sustainable Development and Construction problems is required and to join researchers from other European Union countries with Lithuanian-Polish-German scientists is necessary.
4. It would be useful to create the working group of “Decision-Making in Civil Engineering and Sustainable Development” in the European Association of Operational Research (EURO).

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**STATYBOS KOLOKVIUMO „SUBALANSUOTUMAS IR OPERACINIAI TYRIMAI“
ISTORIJA IR ATEITIES TENDENCIJOS****E. K. Zavadskas****Santrauka**

Straipsnyje aptariama tarptautinio bendradarbiavimo plėtra ir tendencijos tarp trijų akademinų centrų – Vokietijos, Lenkijos ir Lietuvos, apžvelgti vienuolikos konferencijų rezultatai: patirties pasidalijimas (1986–2008), integracija į akademinę bendruomenę, parama tolesniems darbams, kertiniai susitikimų tikslai. Pagrindinė bendradarbiavimo dingstis – sprendimų priėmimo metodai, daugiakriterinis optimizavimas ir darnioji plėtra. Visi vienuolika kolokviimų buvo organizuoti tų pačių mokslininkų. Remiantis kolokviumo medžiaga buvo išspausdinta dešimtys knygų ir daugiau nei 350 mokslinių straipsnių. Čia apžvelgtos pačios svarbiausios mokslinės tendencijos ir išanalizuoti pasiekti rezultatai.

Reikšminiai žodžiai: statyba, subalansuotumas, daugiakriteriniai metodai, operacijų tyrimai, tarptautinis bendradarbiavimas, rezultatai.

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