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Procedia Engineering 122 (2015) 2 – 10

**Procedia
Engineering**www.elsevier.com/locate/procedia

Operational Research in Sustainable Development and Civil Engineering - meeting of EURO working group and 15th German-Lithuanian-Polish colloquium (ORSDC 2015)

Analysis of normalization methods influencing results: a review to honour Professor Friedel Peldschus on the occasion of his 75th birthday.

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Abstract

There is a variety of MCDM methods of solving decision related problems that can be used. Only a combination of normalization and calculation methods is feasible if problems are solved which are to become a foundation of a rational decision. Normalization methods are used in decision-making processes in various fields. Many researchers apply normalization methods in civil and construction engineering and management. Reviews of normalization methods used in construction engineering and management, and their applications there are presented in the paper, as well as a review of research collaboration, achievements, academic activities, and information about one of the founders of the German-Lithuanian-Polish colloquium - Professor Friedel Peldschus. Information about Professor Friedel Peldschus, presented in the paper, has been taken from different data bases which evaluate research work.

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Peer-review under responsibility of the organizing committee of the Operational Research in Sustainable Development and Civil Engineering - meeting of EURO working group and 15th German-Lithuanian-Polish colloquium

Keywords: MCDM, normalisation methods, construction engineering, management.

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1. Introduction

Not many authors have published papers analyzing the influence of normalization methods on calculation results. Normalization procedure is included in each decision aimed at problem solving. In practice, there are not many normalization methods. Normalization methods can influence general results of problem solving.

2. Review: impact of normalization methods

The first analyses of the impact of normalization methods on results of calculations were made by Peldschus and Börner in the 1980s. [1, 2]. Further analyses of impact of normalization methods were made by Peldschus in 1986 [1]. In 2003, LEVI-3 software was created (by Zavadskas *et al.* [3]), making it possible to analyze different types of normalization methods: linear transformation (Körth, DSc-thesis in 1969 [4], Weitendorf in 1976 [5], Jüttler in 1966 [6], and Stopp in 1975 [7]), nonlinear transformation (Peldschus, 1986 [1]) normalization of vectors: Peldschus in 2008 [8]. At first, the impact of normalization methods was applied in calculation processes in context of game theory.

Then, LEVI-4 software was put forward, enabling the analysis of influence of normalization methods on calculation results [9, 10]. In Turskis *et al.* (2009) [11], a new version of LEVI-4 facilitated the use of new logarithmic techniques in context of some aspects of two-sided game problems. Normalization methods used for problem solving in civil engineering are presented in Figure 1.

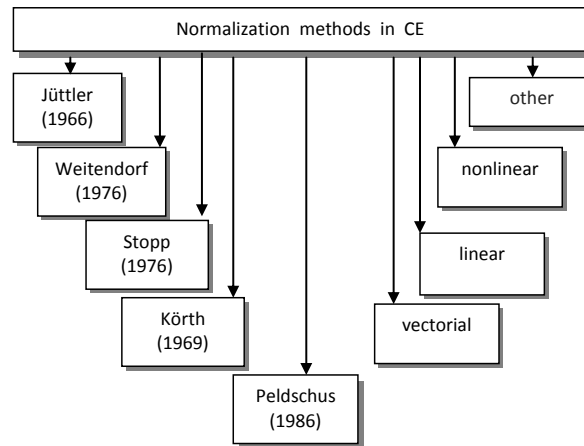


Fig. 1. Normalization methods used for problem solving in civil engineering

The problems of normalisation find their way into a number of interesting applications. In their work, Zavadskas *et al.* [12] analyze normalization of vectors and influence of linear transformation, applied in the TOPSIS method. Opricovic and Tzeng 2004 have analyzed influences of normalization applied in TOPSIS and VIKOR MCDM methods [13]. In their work, Antucheviciene *et al.* (2012) used the TOPSIS-F method based on vector linear normalization for initial values [14].

The influence of normalization methods on calculation results, with the application of TOPSIS, was analyzed by Cellen [15] and Tsaur [16] in their research.

Moreover, in their new research Jahan and Edwards (2015) presented a state-of-the-art survey of influence of normalization techniques in ranking [17].

4. Professor Friedel Peldschus' academic and research achievements

4.1. Professor Friedel Peldschus' biography

Professor Friedel Peldschus is celebrating his seventy fifth birthday. He was born on 7th of April 1940 in Heydekrug (Šilutė). After graduating from secondary school in Mühlhausen in 1958, he worked as a professional driver for the "Deutsche Post". From 1959 to 1965 he studied at the Leipzig TH, and received his Civil Engineering diploma. After graduation, he gained experience in the industry: he worked as a welding engineer and as an IT processes engineer. In addition, he gained practical experience in general construction processes and using steel based technologies in construction. He worked as a design engineer, structural engineer and programmer.

His academic and research work begun in 1968. F. Peldschus was a senior assistant at the Leipzig TH, and Head of the Construction Processes Theory Department. His gave lectures in the following subjects: Fundamentals of Construction Technology, Cybernetics in Civil Engineering and Applications of Mathematical Methods in Construction Technology. His main research area was game theory methodology and its applications with the view to optimize solutions in construction management.

He presented this PhD dissertation in 1972 [18] and defended his habilitation thesis in 1986 [1]. In the autumn semester in 1989, he was a guest lecturer in the Vilnius Civil Engineering Institute (now Vilnius Gediminas Technical University).

He was a member of the „DDR working group on multi-criteria decisions making “and European Working Group "Multi-criteria Aid for Decisions", for which he has worked since 1991. In 1991 Professor Friedel Peldschus was granted honorary (Honoris Causa) doctorate from Vilnius Technical University for his research mathematical methods and their applications in construction industry.

The former name of TH of Leipzig has changed to HTWK (University of Applied Sciences Leipzig), and Professor Friedel Peldschus has worked there as a professor since 1992. Moreover, he played an active role in the university life, and declared readiness to accept the function of the Chancellor in 1993 and 1994. Since 2001 he has been a visiting professor in VGTU. Professor Friedel Peldschus worked at the Civil Engineering Faculty, Leipzig University of Applied Sciences (Germany) until 2005.

Professor Friedel Peldschus was the first to apply game theory to problem solving in civil engineering. His research focused on selection of problem solutions in construction and management. Professor Friedel Peldschus' own published articles, and those in which he was a co-author, include the following subjects: solution appreciative goals (Peldschus *et al.* 1983 [19]); game theory application in construction technology (Fiedler and Peldschus 1983 [20]; Peldschus 1985 [21]; Fiedler *et al.* 1986 [22]); optimisation of floor finishing process by applying one criterion (Peldschus and Zavadskas 1984 [23]); matrix game in preparatory work in construction technology (Peldschus and Fiedler 1984 [24]; Peldschus *et al.* 1986 [1], Peldschus *et al.* 1988[25]; Peldschus *et al.* 1990 [26]); a new concept of dimension of concrete production technological line (Altmann *et al.* 1987 [27]); game modelling in preparation for construction production (Peldschus *et al.* 1989 [28]); rational machinery selection combination and in earthworks (Herschel and Peldschus 1989 [29]); solution problems models in construction (Peldschus 1990[30]); multi-criteria decision support system (Peldschus and Löhne 1991 [31]; Löhne and Peldschus 1993 [32]); calculation of management parameters in sustainable construction processes (Peldschus *et al.* 1990b [33]); comparison analysis for construction management (Peldschus 1992 [34], 1994 [35]) and construction processes (Peldschus 1994 [36]); assessment problems in multicriteria decision making (Peldschus 1993 [37], Zavadskas and Peldschus 2003 [38]); a system for decision making theory in a program (Löhne *et al.* 1990 [32]); in 1993, LEVI was developed - a program for solving multiple criteria decision making problems (Löhne and Peldschus [39]; Zavadskas *et al.* [40]) and in 2002, the improved version of the multiple criteria evaluation program - LEVI 3.0 - was developed (Peldschus 2000 [41]; Peldschus *et al.* 2001 [42]; Peldschus *et al.* 2002 [43]; Zavadskas *et al.* 2002 [44]); development of software for multiple criteria evaluation (Zavadskas *et al.* 2003 [45]); sensitivity in decision making methods (Peldschus 2001 [46]); construction market analysis (Peldschus and Reichelt 2001 [47]); assessment of crack mechanics in buildings refurbishment (Peldschus and Wild 2002 [48]); improvement of efficiency of the production planning in small and medium-sized construction companies (Wild and Peldschus 2002 [49]); civil and environmental risk management in engineering projects (Reichelt and Peldschus 2005 [50]); fuzzy methods in construction (Peldschus 1995 [51], 2003

[52]) and fuzzy matrix games multi-criteria model for decision-making in engineering (Peldschus and Zavadskas 2005 [53]); quality problems in construction (Peldschus 1997 [54]); requirements of buildings refurbishment (Peldschus 1998 [55]); research in construction processes optimization (Peldschus 1999 [56]); economic analysis of project management, considering multi-criteria decisions (Peldschus 2006 [57]); effectiveness assessments in multi-criteria decision making (Peldschus 2007 [58]); game-theory solutions in construction operations (Peldschus 2007 [59]); multi-attribute assessment of road design solutions using the COPRAS method (Zavadskas *et al.* 2007 [60]); decision making in road design (Peldschus 2004 [61], 2005 [62]; Brauers *et al.* 2008 [63-64]); MADM in construction (Peldschus 2008 [65]); game theory application in construction management (Peldschus 2008 [66]); game-theory solutions in construction operations (Peldschus 2008 [67]); multi-criteria optimization system for decision making in construction design and management (Turskis *et al.* 2009 [68]); construction design project managers qualifying by applying Analytic Hierarchy Process and Bayes rule (Vainiūnas *et al.* 2009 [69]); the analysis of the quality of results obtained using multi-criteria decisions methods (Peldschus 2009 [70]); sustainable assessment of a construction site by applying game theory (Peldschus *et al.* 2010 [71]).

The books and monographs represent his main research achievements: methods for the investment phase and the study of construction production (Fiedler *et al.* 1983 [72]); decision making methods for construction technology (Fiedler *et al.* 1986 [22]); application of game theory in preparation for construction industry production (Zavadskas and Peldschus 1986 [73]); multiple criteria evaluation of projects in construction industry (Zavadskas *et al.* 1994 [74]); matrix games in construction technologies and management (Peldschus and Zavadskas 1997 [75]); game theory in construction technology and management (Zavadskas *et al.* 2004 [76]). Most of books and monographs have been published in collaboration with German and Lithuanian colleagues. The reviews of these books were published in scientific journals (Rutkauskas [77]; Skitmore and Koznan [78]; Ginevičius, [79]; Podvezko [80]).

Professor Friedel Peldschus has been actively collaborating with his colleagues from abroad, and has written a number of some forewords to their publications (Peldschus [81, 82]) and book reviews (Štercelis and Peldschus [83]; Peldschus [84, 85]).

His scientific achievements in game theory have been further developed scientists from abroad: Zavadskas and Vaidogas ([86, 87]) proposed the models based on games theory; Kaplinski presented usefulness and credibility of scoring methods in construction industry [88] and application of utility theory [89, 90]; Zavadskas and Turskis proposed a logarithmic normalization method [91]; Zavadskas *et al.* wrote about selecting a construction contractor applying the game theory [92].

During 47 years of academic and research activity, Professor Friedel Peldschus supervised 8 PhD students, successfully participated the numerous PhD and Post PhD thesis presentations, published about 40 articles in very high rated scientific journals, published about 15 proceedings: in total, approximately 90 scientific papers. He participated in the publishing of 6 books. His articles and books were published in 4 different languages: English, German, Russian and Lithuanian.

4.2. Specific information about Professor Friedel Peldschus in a variety of databases

Nowadays, research is evaluated on the basis of information contained in different types of databases, of which the most popular is ISI Web. Information from different databases is presented in Table 1.

Table 1. Specific information about Professor Friedel Peldschus in a variety of databases

Database name	Numerical data (as of: 29 April 2015)		
	Number of papers	Number of quotations in total	h-index
ISI Web of Science	16	466	8
SCOPUS	15	433	8
GOOGLE SCOLAR	82	983	15
Publish or Perish	139	1465	16

4.3. The German-Lithuanian-Polish colloquium and EURO Working Group “OR in Sustainable Development and Civil Engineering”

Scientific cooperation between the three academic centres from Germany, Lithuania and Poland, in which the scientists represented their universities: Prof. F. Peldschus (Leipzig University of Applied Sciences), Prof. E. K. Zavadskas (Vilnius Gediminas Technical University), and Prof. O. Kapliński (Poznan University of Technology) [93, 97], is presented. Formal meetings have been called Colloquia, and were organized every two years in different academic centres. The initiating members of the first colloquium, held in 1986, were: Prof. K. Fiedler (Leipzig Higher Technical School), Dr. F. Peldschus (Leipzig Higher Technical School) and Dr. E. K. Zavadskas (Vilnius Civil Engineering Institute). The second colloquium was held in 1989, and a representative from Poland Prof. O. Kaplinski was invited ([91, 94, 95]). As a result of productive collaboration during Colloquia, several postdoctoral theses and doctoral dissertations were written and defended, research papers and books were published and conferences were organized with published proceedings, etc. On the basis of these achievements, the EURO Working Group OR in Sustainable Development and Civil Engineering (EWG-ORSDC) was established (Tamosaitiene et al. 2010 [94]). The decision to establish EURO Working Group “OR in Sustainable Development and Civil Engineering” was taken after a long international collaboration between researchers from several European countries (Lithuania, Germany, Poland, United Kingdom, Belgium, Denmark, Latvia, Estonia, Czech Republic, Slovenia). The working group was created at EURO Conference XXIII in 2009, Bonn (Germany). Currently, the group comprises of more than 100 scientists from 20 countries (Lithuania, Germany, Poland, United Kingdom, Belgium, Denmark, Netherlands, Portugal, Latvia, Estonia, Czech Republic, Slovenia, Russia, Ukraine, Australia, Iran, USA, Taiwan and others), but at the early beginning research group consisted of professors from the only Lithuanian, German and Polish academic and research centres. As a sign of significance and uniqueness of the origins of collaboration of this research group, was later referred to in articles as the “Scientific Triangle”.

Collaboration in exchanging of research achievements, consulting on publications, cooperating on joint papers, supporting the future research: all that was implemented through organization of colloquia, which were held every two years in different academic centres and covered different areas. To give a few examples, the topic of 13th colloquium, held in 2011, was “Civil Engineering Projects”, and the topic of 14th colloquium, held this year, is “Innovative Solutions in Construction Technology and Management”.

Scientific cooperation started by three academic centres: the Leipzig University of Applied Sciences (Applied Sciences - Germany), Vilnius Gediminas Technical University (Vilnius Gediminas Technical University - Lithuania) and Poznan University of Technology (PUT - Poland) in the form of colloquia, celebrated the twenty-fifth anniversary in 2011.

Every colloquium, beginning from the first one held in 1986, to the last one has greatly contributed to publishing research papers and books, developing research, preparing doctoral dissertations and to their international recognition. The cooperation had fruitful scientific results: 45 scientific books published, including 8 scientific monographs; more than four hundred articles published in scientific journals; 13 habilitation processes initiated or successfully concluded; 54 doctoral students presented and defended their doctoral dissertations in Civil Engineering (Zavadskas and Vilutiene 2013 [95]).

Professor Friedel Peldschus 75th Jubilee serves as a pretext to present his academic and scientific achievements. His contribution to development of game theory applications in construction and management [96-99], as well as to developing international academic collaboration has been discussed. A review of research and academic achievements of Professor Friedel Peldschus has been presented.

We wish Professor Friedel Peldschus good health and much creativity, so that we can continue to welcome him to our joint activities. On the day of his Jubilee, we would like to congratulate the scientist of the greatest format, the person whose merits and contributions to the development of international collaboration of academic communities are impressive. On his Jubilee, we wish him all the best, lots of success and, most of all, satisfaction from witnessing the success of his colleagues from abroad.

Conclusion

A review of influence of normalization methods is presented in this paper. The methods have been developing dynamically and have a variety of dimensions. Professor Friedel Peldschus has greatly contributed to their development. Professor F. Peldschus' work during 47 years, presented in this paper, has promoted scientific achievements, fostered collaboration, partnership and exchange of knowledge of best practices. His research and scientific work was a foundation to organizing the German-Lithuanian-Polish colloquium, and the "OR in Sustainable Development and Civil Engineering" EURO Working Group. His work for the EURO and the 'Association of European Operational Research Societies' within IFORS, the 'International Federation of Operational Research Societies' has been outstanding.

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