



EWG-ORSDCE

NEWSLETTER OF EWG ORSDCE DECEMBER 2015

ORSDCE - The OR in Sustainable Development and Civil Engineering Working Group of EURO
<http://www.orsdce.vgtu.lt/>

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Words of chairman

Dear Members of EWG-ORSDCE, dear Friends,

Another year has come to an end, and it's time to summarize the results. It is a great pleasure to address you some introductory words and present the achievements of scientific cooperation.

This year was rich in scientific and other events where members of EWG-ORSDCE have met. This year the EWG-ORSDCE meeting in form of 15th German-Lithuanian-Polish colloquium have been held in Poznan, Poland. This Newsletter presents the brief report with pictures on this event. On behalf of coordinating board of EWG-ORSDCE I would like to express gratitude to the EURO "Association of European Operational Research Societies" and sponsors from Polish construction industry for the support provided for organization of the EWG-ORSDCE meeting and conference. We would like to thank everyone who contributed to the organization of colloquium in a relatively short period of time. Special thanks to dr. Marcin Gajzler, who was the Chairman of the Organizing Committee, for exceptional commitment and creativity. Thanks to the members of Scientific Circle *ConInno* for supporting us in organizing the conference. Special thanks for all participants of meeting in Poznań-Puszczykowo. We hope for fruitful continuation of cooperation within cyclic meetings of German-Lithuanian-Polish Colloquium and Meetings of EURO working group Operational Research in Sustainable Development and Civil Engineering. Next year the Colloquiums celebrate 30 year anniversary. We invite to join us in next year meeting that will be held in Poznan also as the Workshop at EURO conference.

Partners from Warsaw University of Technology (Poland), Valencia Polytechnic University (Spain), Poznan University of Technology (Poland), Vilnius Gediminas Technical University (Lithuania), Minho University (Portugal), Polish Association of Building Managers (Poland), The Chartered Institute of Building (United Kingdom) finalized the MBAIC project. Collaborators of project have met several times in Poland, Spain, Portugal, UK and Lithuania for discussion of project activities and directions for future collaboration. The Newsletter presents the results and expected further impact on industry in communities.

The EWG-ORSDCE conventionally contributes to the organization of EURO conferences. This year during the 27th European Conference on Operational Research, which was held in Glasgow, United Kingdom, on July 12-15, 2015, EWG-ORSDCE organized the Invited Session in stream "*OR for Sustainable Development*" belonging to area "*OR for Developing Countries, Humanitarian Applications*". We would like to express the gratitude to colleagues contributed to the organization of this stream, especially for dr. Vida Maliene, who chaired the session.

This year was reach of scientific papers, the list is presented in separate section. This year was signified by appearance of new optimization methods belonging to the group of WASPAS (Weighted Aggregates Sum Product Assessment) methods. The article "*Recent approaches to extend the crisp WASPAS method into a fuzzy environment in order to deal with uncertain information*" included in this Newsletter is presenting the group of WASPAS methods.

We wish you fruitful scientific collaboration, plenty of health, happiness and prosperity in the New Year!

With my best wishes, yours sincerely,

Edmundas Kazimieras Zavadskas

Chair of EWG-ORSDCE coordinating board

Forthcoming Events



28th European Conference
on Operational Research

EURO
The Association of European
Operational Research Societies



28TH EUROPEAN CONFERENCE ON OPERATIONAL RESEARCH

Poznan, [Poland](#)

July 03-06, 2016

Poznan University of Technology

EURO2016 takes place from Sunday 03 - Wednesday 06 July 2016 in the Poznan University of Technology in Poznan, which is one of the leading European centers in decision analysis, optimization, project management, and scheduling - is a perfect place to share cutting edge ideas from the OR/MS community. The main conference venue is the modern university campus at the riverside, located close to the historical center of Poznan. The central plenary lecture will be hosted by Poznan International Fair in the beautiful Earth Hall.

The Program and Organizing Committees, chaired by Daniele Vigo and Joanna Józefowska, respectively, are preparing a high quality scientific program and an exciting social program. All researchers, academicians, practitioners, as well as students interested in any topic in operational research are invited to participate in the conference and to present their papers.

Oral presentations will be organized in parallel sessions. Authors can present only one paper at the Conference. Submission invited on, but not limited to, the following areas:

- *Analytics, Data Science, Data Mining*
- *Artificial Intelligence, Fuzzy Systems*
- *Continuous Optimization*
- *Control Theory & System Dynamics*
- *Decision Analysis, Decision Support Systems, DEA and Performance Measurement*
- *Discrete Optimization, Mixed Integer Linear and Nonlinear Programming*
- *Emerging Applications of OR*
- *Energy, Environment, Natural Resources and Climate*
- *Financial Modelling, Risk Management and Managerial Accounting*
- *Game Theory, Mathematical Economics*
- *Graphs and Networks*
- *Metaheuristics*
- *Multiple-Criteria Decision Making and Optimization*
- *OR History and OR Ethics*
- *OR Education*
- *OR for Developing Countries, Humanitarian Applications*
- *OR in Health, Life Sciences & Sports*
- *OR in Industry and Software for OR*
- *OR in Natural Resources*
- *Practice of OR (Making an Impact)*
- *Production Management & Supply Chain Management*
- *Revenue Management*
- *Routing, Location, Logistics and Transportation*
- *Scheduling, Time Tabling & Project Management*
- *Simulation, Stochastic and Robust Optimization*
- *Soft OR and Problem Structuring Methods*

Important dates:

Abstract Submission Start	1 October 2015
Registration Start	2 November 2015
Abstract Submission Deadline	1 March 2016
Notification of Acceptance	31 March 2016
Early Bird Registration/Payment Deadline	1 April 2016
Author Registration/Payment Deadline	15 April 2016 *
Conference Start Date	3 July 2016
Welcome Reception	3 July 2016
Conference Dinner	5 July 2016
Conference End Date	6 July 2016

More information: <http://www.euro2016.poznan.pl/>

Registration fees:

Registration Category	Early bird registration until April 1st 2016	Regular registration After April 15th 2016
Regular	€ 375	€ 500
Students	€ 200	€ 300

The registration fee includes:

- Admission to sessions and the exhibition
- Access to all conference materials (in appropriate format)
- Tea, coffee and lunch throughout the conference
- Admission to the Welcome Reception on 3 July 2016
- Three-day ticket for public transport in Poznan

Submit your abstract (max 600 characters) on line:

<https://www.euro-online.org/euro28/registration/register/>

DO ZOBACZENIA!

ORSDCE2016 Workshop on Flexibility in Sustainable Construction

Place: Poznan, Poland

Date: July 7-8, 2016,

ORSDCE2016 Workshop is a satellite workshop of [The 28th annual EURO conference](#) held in Poznan, Poland, 7-8 July 2016. The location of the EURO 2016 will be in Poznan. [Poznan University of Technology](#) will organize it with the European Association of Operational Research Society and the Polish OR Society.

Venue of Workshop – Poznan University of Technology, PL- 60-965 Poznan, 5 Piotrowo Str.

General aims of this event:

- dissemination of innovative solutions between academia and industry, students and industry
- knowledge bridge creation
- exchange experience in the field of science
- inspiration of young researchers to work in their field of interest
- development of new ideas and solutions with partners from industry

Objectives of the workshop:

- to discuss new trends in Flexibility in Construction Management
- to strengthen cooperation within EURO working group
- to discuss possible grant application in Horizon 2020 based on EU founding

General plan of the workshop:

7.06.2015 – Invited lectures, Industry-academy cooperation, PhD presentation

8.06.2015 – „on site“ conference – case study: trip to the industrial partners, analysing real life examples of discussed topics.

More information will be provided soon on the website: <http://www.scfm.put.poznan.pl/>

Topics that will be covered during the workshop:

- Sustainability in construction
- Energy Management
- LSS
- LCA
- LCCA
- Construction Management
- Social, technical, economical aspects of construction
- Logistics
- BIM

We invite submission to the following areas (but not limited to):

· flexible management · lean management · building information management (BIM) · energy management · agile management · operational research · decision making · decision support system · innovative solutions · civil engineering · construction technology and organization · sustainable development in civil engineering · construction management · flexible design of infrastructure · technological flexibility · buildings life cycle · real estate management · logistics

in construction · project management · quality management · modular construction · build environment

Website: <http://www.scfm.put.poznan.pl/>

Programme committee

Richard de Neufville (MIT, USA)
Dominik Matt (FU Bolzano, Italy)
Edmundas Kazimieras Zavadskas (VGTU, Lithuania)
Leonidas Sakalauskas (Institute of Mathematics and Informatics, Lithuania)
Zenonas Turskis (VGTU, Lithuania)
Tatjana Vilutiene (VGTU)
Jerzy Paślawski (PUT, Poland)
Zenon Kierczyński (WIB, Poland)
Janusz Signietzki (WPIP, Poland)
Leszek Janusz (Viacon, Poland)
Henryk Gierszal (ITTI, Poland)
Tomasz Rudnicki (GDDKiA, Poland)

Local Organising committee:

dr. hab inż. Jerzy Paślawski, prof. PP.
dr inż. Marcin Gajzler
mgr inż. Maria Kośmiejka
mgr inż. Aneta Kończak
mgr inż. Roman Milwicz
mgr inż. Sebastian Dubas
mgr inż. Piotr Nowotarski

Abstract submission Jan 15 - Mar 15, 2016

Abstract acceptance Mar 31, 2016

Early-bird registration Apr 30, 2016

ORSDCE2016 Workshop on Flexibility in Sustainable Construction is the new annual event of the ORSDCE - The OR in Sustainable Development and Civil Engineering Working Group of EURO (The Association of European Operational Research Societies), held in collaboration with the 28th annual EURO-k conference to be held in Poznań on July 7-8, 2016.

12th International Conference "Modern Building Materials, Structures and Techniques"

26–27 of May, 2016
Vilnius, Lithuania

12th international conference "Modern Building Materials, Structures and Techniques" in Vilnius, Lithuania, on 26–27 of May, 2016. The conference will provide an opportunity for scientists, engineers, managers and professionals from around the world to share the latest achievements and to highlight the problems. Such a conference will be an excellent opportunity to meet colleagues, to exchange knowledge and experience, and to extend your list of contacts. Starting from year 1991, faculty of Civil Engineering at Vilnius Gediminas Technical University (VGTU) together with national and international partners already has organized eleven highly successful international scientific conferences to discuss up-to-date problems in civil engineering. This conference is aimed at discussing of both industrial and academic research which has been recently carried out on analysis and design of modern structures, development of innovative building materials, maintenance of structures, building technology and management, etc. The 11th international conference "Modern Building Materials, Structures and Techniques", held on 16–17 of May, 2013, was attended by nearly 400 scientists from more than 20 countries. The peer-reviewed selected papers of the previous conferences were indexed by Thomson Reuters Conference Proceeding Citation Index (ISI Conference Proceedings database). The links to the full papers of recent conferences are available on the Conference internet site <http://mbmst.vgtu.lt> (Archive section).

Submission invited on, but not limited to, the following areas: *(to be supplemented)*

*Building materials and production technology; Innovative analysis and design methods for bridges and building structures; Behaviour and design of concrete, masonry, glass, steel, timber and composite structures; Stability of steel and composite structures; Repair, renovation and strengthening of bridges and building structures; Geotechnics; Optimization in structural engineering; Architectural engineering; Construction technology and organization; **Decision making, decision support systems and management in construction; Operational research; Building information system; Facility and real estate management; Fire safety, human safety and ergonomics***

Honorary committee: E. K. Zavadskas (Lithuania); A. Daniūnas (Lithuania); H. A. Mang (Austria)

Scientific committee:

Chairman: A. Juozapaitis (Lithuania)

Members: H. Adeli (USA); P. Alawdin (Poland); J. Atkočiūnas (Lithuania); R. Bairrao (Portugal); G. L. Balazs (Hungary); R. C. Barros (Portugal); R. Belevičius (Lithuania); H. Brandl (Austria); D. Camotim (Portugal); J. Eberhardsteiner (Austria); J. Galaj (Poland); T. V. Galambos (USA); K. Ghavami (Brasil); R. Gilbert (Australia); M. Giżejowski (Poland); K. Holschemacher (Germany); G. I. Jakovlev (Russia); S. Idnurm (Estonia); J. P. Jaspart (Belgium); R. Kačianauskas (Lithuania); G. Kaklauskas (Lithuania); A. Kaklauskas (Lithuania); Z. Kala (Czech Republic); O. Kaplinski (Poland); R. Katzenbach (Germany); R. Kliukas (Lithuania); J. Korjamins (Latvia); A. K. Kvedaras (Lithuania); P. L. NG Lamas (China); J. Lellep (Estonia); R. Liias (Estonia); T. Lodygowski (Poland); J. Macháček (Czech Republic); R. Mačiulaitis (Lithuania); A. Mandolini (Italy); G. Marčiukaitis (Lithuania); L. Mica (Czech Republic); A. Norkus (Lithuania); B. Pacewska (Poland); A. Paeglitis (Latvia); J. Parasonis (Lithuania); H. Pasternak (Germany); K. Pilakoutas (UK); K. Rasmussen (Australia); T. F. Ronning (Norway); M. J. Skibniewski (USA); G. Skripkiūnas

(Lithuania); A. Šapalas (Lithuania); R. Šukys (Lithuania); V. M. Ulitsky (Russia); L. Ustinovičius (Lithuania); J. Valivonis (Lithuania); F. Wald (Czech Republic); R. Ziemian (USA); M. Ziegler (Germany)

Organizing committee:

Chairman: L. Juknevičius (Lithuania)

Members: R. Zavalis; L. Kanapeckienė

Conference presenters/authors are asked to upload their manuscripts online. Please note that only registered users are able to upload their papers. Guidelines for authors will be available on the Conference internet site <http://mbmst.vgtu.lt>

Publishing

All the peer-reviewed Conference papers will be published in electronic format. Published papers will be sent immediately to Thomson Reuters **Conference Proceeding Citation Index** (ISI) and **SCOPUS** for possible indexing.

Important Dates

November 2015 – opening of on-line registration and paper submission system

by 1st of February 2016 – submission of papers

by 29th of February 2016 – submission of papers corrected according to reviewers comments

by 1st of April 2016 – payment of early (reduced) conference fee

by 13th of May 2016 – payment of full conference fee

26–27th of May 2016 – Conference

Fees

PARTICIPANT (Oral or poster presentation) - **350.00 EUR** before 2016-04-01 and **450.00 EUR** thereafter.

Fee includes: attendance to all conference sessions, publishing of the paper in electronic format, coffee breaks, participant card, printed conference programme, paper notebook, pen, bag, lunches, invitation to gala dinner, social programme, tourist information

STUDENT (Oral or poster presentation. Valid student card/ID with picture should be presented during registration) - **245.00 EUR** before 2016-04-01 and **315.00 EUR** thereafter.

Fee includes: attendance to all conference sessions, publishing of the paper in electronic format, coffee breaks, participant card, printed conference programme, paper notebook, pen, bag, lunches, invitation to gala dinner, social programme, tourist information

ACCOMPANYING PERSON - **200.00 EUR** before 2016-04-01 and **250.00 EUR** thereafter.

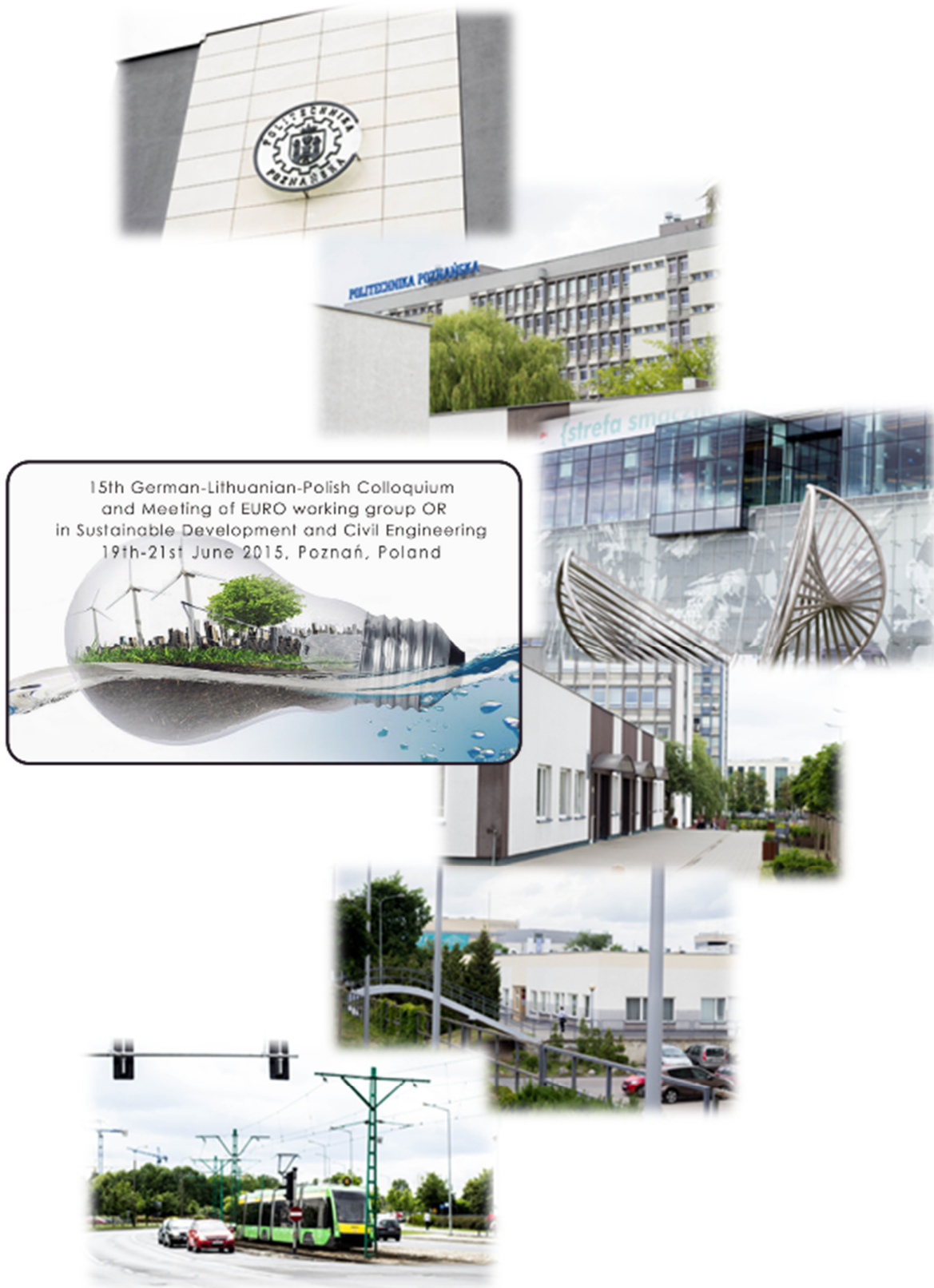
Fee includes: attendance to all conference sessions, coffee breaks, participant card, lunches, invitation to gala dinner, social programme, tourist information

Payment must be done in Euros and by bank transfer only. Cash payment will be not accepted. Detailed payment information will be provided on Conference internet site <http://mbmst.vgtu.lt>

Organizers & Partners

The Conference is organized by *Faculty of Civil Engineering, Vilnius Gediminas technical university* and partners: *Lithuanian group of International Association for Bridge and Structural Engineering, European Council of Civil Engineers, The Association of European Civil Engineering Faculties, The Association of European Operational Research Societies (EWG-ORS DCE), The Lithuanian Academy of Sciences.*

Scientific events 2015



The meeting of EWG-ORSDCE members - The 15th German-Lithuanian-Polish colloquium „Innovative solutions in Construction Engineering and Management “

The meeting of EWG-ORSDCE in form of 15th German-Lithuanian-Polish colloquium was held on June 19 - 21, 2015 in Poznan, Poland under honorary patronage of prof. Tomasz Łodygowski – Rector of Poznan University of Technology.

Papers of 15th German-Lithuanian-Polish Colloquium covered these broadly defined areas: decision making, decision support system; innovative solutions; sustainable development in civil engineering; sustainable build environment; buildings life cycle; construction technology and management. Papers in this area covered concepts of „Innovative solutions in construction engineering and management“ and also development and applications of MCDM methods.

During the meeting the special panel “*Practice Synergy in Construction Industry*” was organized for the reason to gather a wider audience from industry for promoting the research in OR and foster the joint initiatives.

The papers presented during the Colloquium have been published in special issue of [Procedia Engineering](#) *Innovative solutions in Construction Engineering and Management. Flexible Approach* (Volume 122, Pages 1-320, 2015).

The issue includes 41 articles authored by the members of EURO working group “OR in Sustainable Development and Civil Engineering” who were in attendance at this international meeting. The manuscripts were presented during the Colloquium, all papers were peer reviewed.

The meeting of EWG-ORSDCE was sponsored by the [EURO](#) “Association of European Operational Research Societies” within [IFORS](#), the “International Federation of Operational Research Societies”, civil engineering and construction companies: [ViaCon](#) Poland branch, [Walbet](#) and [Pekabex](#).

Sponsored by

The logo for EURO, consisting of the word "EURO" in a stylized, blocky, blue font.

The Association of European
Operational Research Societies

The logo for ViaCon, featuring a stylized blue icon of a building or structure to the left of the word "ViaCon" in a blue sans-serif font.The logo for Walbet, featuring a stylized red and white icon of a building or structure to the left of the word "WALBET" in a bold, blue sans-serif font.The logo for Pekabex, featuring a stylized green icon of a building or structure to the left of the word "Pekabex" in a green sans-serif font.

The invitation and agenda of meeting

15th German-Lithuanian-Polish colloquium
and Meeting of EURO working group OR
in Sustainable Development and Civil Engineering
June 19th - 21st, 2015, Poznań, Poland

15 Deutsch-Litauisch-Polnisches Kolloquium
und Treffen der EURO Arbeitsgruppe OR
für nachhaltige Entwicklung im
Bauingenieurwesen
19 – 21 Juni 2015, Poznań, Polen

15-tas Vokietijos-Lietuvos-Lenkijos kolokviumas
ir EURO darbo grupės „Operacijų tyrimai
subalansuotoje plėtroje ir statyboje“ susitikimas
birželis 19-21 d., 2015, Poznań, Lenkija

15 Niemiecko-Litewsko-Polskie Kolokwium
oraz spotkanie Grupy Roboczej EURO „Badania
operacyjne w zrównoważonym rozwoju
i budownictwie“.
19-21 czerwca 2015, Poznań, Polska

Innovative solutions in Construction Engineering and Management



We are pleased to invite you to the joint meeting of researchers and practitioners active in the field of construction management: 15th German-Lithuanian-Polish colloquium and 4th meeting of EURO working group OR in sustainable Development and Civil Engineering. This EURO working group was created by Professor Edmundas Kazimieras Zavadskas and is animated by Associate Professor Tatjana Vilutiene from VGTU. As part of this meeting, we are also planning a working meeting in the framework of the Leonardo da Vinci project, which is an example of collaboration among members of our group activity.

Conference topics

• operational research • decision making • decision support system • innovative solutions in civil engineering • construction technology and organization • sustainable development in civil engineering • construction management • buildings life cycle • qualification of human resources • real estate management • project management • quality management • build environment • and special event: *Science-Practice Synergy in Construction Industry*

Honorary Patronage

T. Łodygowski – Rector of PUT

Honorary Committee

E. K. Zavadskas (Lithuania)
O. Kapliński (Poland)

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P. Nowak
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E. Plebankiewicz
M. Poloniski
J. Šelih
A. Sobotka
Z. Turskis
T. Vilutiene

Organizing committee

Chairman: M. Gajzler (Poland)
T. Vilutiene (Lithuania)
Tel.: 0048 61 6652190
Fax: 0048 61 8766116
Marcin.Gajzler@put.poznan.pl
Tatjana.Vilutiene@vgtu.lt

Conference organization actively support
students from research circle

CON INNO



Abstract and papers submission

Papers must be written in English. Papers after the process of reviewing will be published in the Book of Abstracts (during the Conference) and finally (October/November) in *Procedia Engineering* (Elsevier).

Authors of the selected conference papers will be offered to supplement or modify their papers for possible publishing in the following scientific journals: *Journal of Civil Engineering and Management* (VGTU and Taylor & Francis), WOS, IF=1,372 (2013) *Technological and Economic Development of Economy* (VGTU and Taylor & Francis), WOS, IF=2,818 (2013) *International Journal of Strategic Property Management* (VGTU and Taylor & Francis), WOS, IF=1,423 (2013), and others journals opened to scope of Construction Engineering and Management.

Important dates and registration

Registration for conference: 15th German-Lithuanian-Polish colloquium and 4th meeting of EURO working group OR in Sustainable Development and Civil Engineering is opened from 30th January till 30th March, 2015.

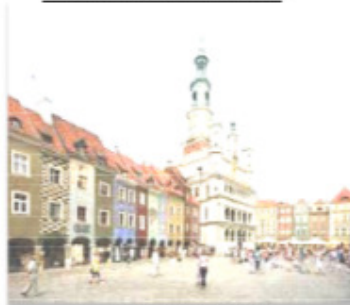
Full paper submission - 30th May, 2015

Payment for Conference - 30th April, 2015

Conference fee - 250 EUR (incl. accommodation)

Account number: 39 1540 1056 2001 8312 9885 0001
SWIFT CODE: EPOS PL PW
Account holder: Towarzystwo Poligrodzianie
Address: Lanowa 18, 62-081 Przemierowo, Poland
Please, make bank transfer with adnotation
„XV SDCE Meeting – name of participant“

Conference venue: POZNAN



Poznań University of Technology



Wielkopolski National Park - Puszczykowo



Innovative solutions in Construction Engineering and Management

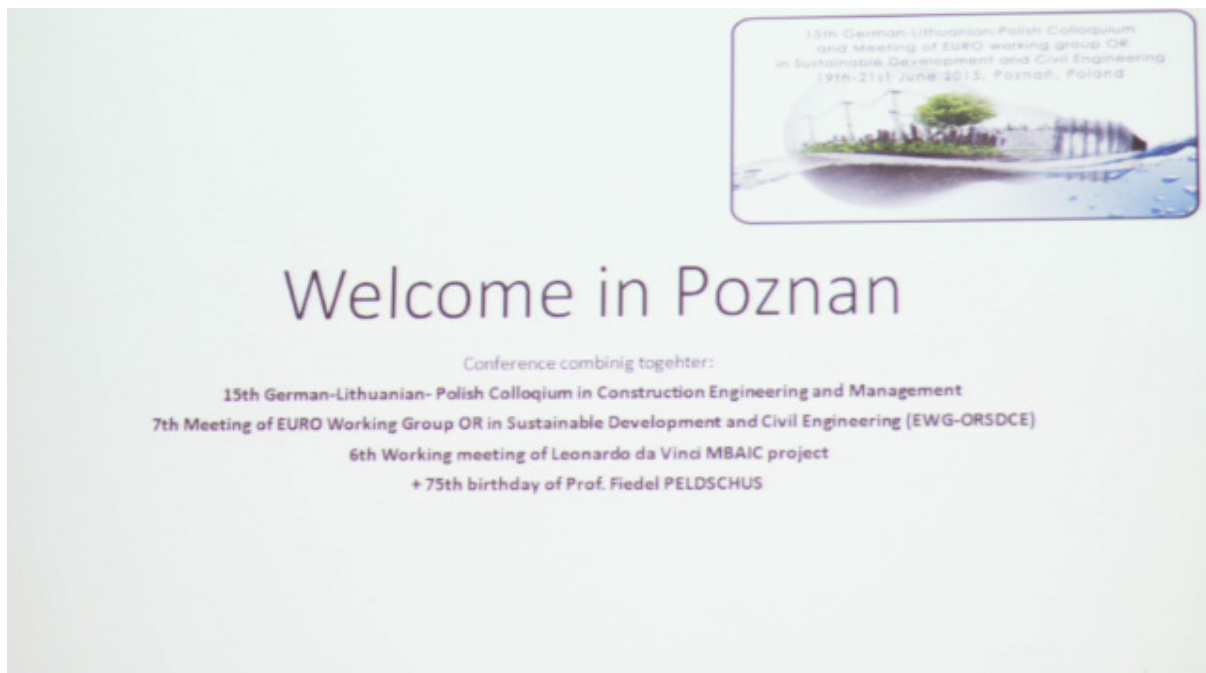
General Program

Friday, 19th June (PUT)
12.00-13.00 Conference opening
13.00-14.30 Special panel "Science – Practice Synergy
in Construction Industry"
14.30 – 15.30 Lunch
15.30 – 18.00 Problem session
18.00 Departure to Puszczykowo
19.00 Dinner

Saturday, 20th June (Puszczykowo)
8.00-9.00 Breakfast
9.00-10.30 Special session for PhD Students -
Discussion forum
11.00 – 12.30 Problem session
12.30 – 13.30 Lunch
13.30 – 15.00 LdV session
15.00 – 18.00 Social program
18.00 Dinner

Sunday, 21st June (Puszczykowo)
8.00 – 9.00 Breakfast
9.00 – 10.30 Problem session
11.00 – 12.00 Conference closing
12.30-13.30 Lunch

More information - see at Web page of conference
<http://www.ztiob.put.poznan.pl/d2/conference>



Vice-Rector for Research prof. dr hab. inż. Joanna Józefowska, Director of Institute of Structural Engineering prof.dr hab.inż. Józef Jasiczak and dr hab. inż. Jerzy Paślawski chairing the meeting.



Vice-Rector for Research prof. dr hab. inż. Joanna Józefowska opening the conference and wishing the nice stay in Poznan.



Prof. Jerzy Paslawski presenting the agenda of meeting.



Business history of our triangle was set out in detail by Prof. Oleg Kaplinski, who cared about the development of this initiative, enlisting the cooperation of Prof. Reinhard Seeling from the RWTH Aachen.



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), Prof. O. Kaplinski (Poznan University of Technology) and Dr. E. K. Zavadskas (Vilnius Civil Engineering Institute).



“This colloquium should be for young scientists!” – asserted Prof. Oleg Kaplinski.



Assoc. prof. dr. Tatjana Vilutienė presenting the EWG ORSDCE initiatives to rise excellence and sustainability in construction and expressing special thanks for young researched created the logo of conference reflecting the main ideas of sustainability.



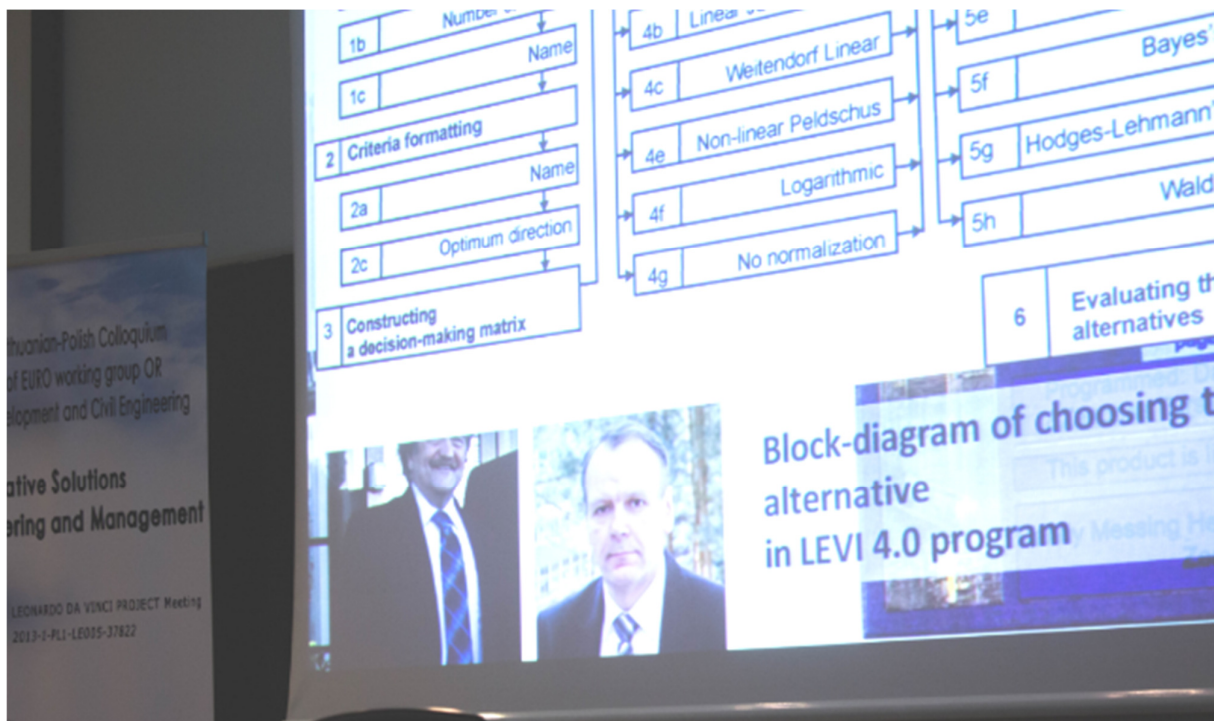
The discussion of EWG members' initiatives excellence and sustainability in construction continued prof. habil dr. Leonas Ustinovičius by presenting the conception of BLM – Building Life-Cycle Management.



During the meeting of EURO working group „OR in Sustainable Development and Civil Engineering“ the possibilities of cooperation in preparing proposals for international research projects in field of smart specializations were discussed.



Professor Oleg Kaplinski presented review of normalization methods used in construction engineering and management and their applications, 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.



Prof. Oleg Kaplinski discussed with audience the contribution of prof. Friedel Peldschus to the development of game theory applications in construction and management.



The evolution of Colloquium interests of participants is worth paying attention – from classical quantitative approach (mathematical methods) to applying the methods of computer aided approach based on proactivity flexibility now.

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. Collaboration continues in exchanging of research achievements, consulting on publications, cooperating on joint papers, supporting the future research: all that was implemented through organization of colloquiums, 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 in 2013 year, is “Innovative Solutions in Construction Technology and Management”.

Contribution of prof. F.Peldschus (HTWK Leipzig) should be especially underlined, who this year celebrates his 75th birthday. His contribution in the field and game theory and LEVI software development deserves special recognition.

His scientific achievements in game theory have been further developed scientists from abroad: prof. Edmundas Kazimieras Zavadskas and prof. Egidijus Rytas Vaidogas proposed the models based on games theory; prof. Oleg Kaplinski presented usefulness and credibility of scoring methods in construction industry and application of utility theory; prof. Edmundas Kazimieras Zavadskas and prof. Zenonas Turskis proposed a logarithmic normalization method; prof. Edmundas Kazimieras Zavadskas wrote about selecting a construction contractor applying the game theory.

Professor F. Peldschus' work during 47 years, 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.



Full review read in article:

O.Kaplinski, J. Tamošaitienė. Analysis of normalization methods influencing results: a review to honour Professor Friedel Peldschus on the occasion of his 75th birthday, *Procedia Engineering* 122 (2015) 2 – 10.

In special panel “Science – Practice Synergy in Construction Industry” representatives of event sponsors - the ViaCon Group and Pekabex companies presented the most important construction projects and applied innovative technologies.



ViaCon and Pekabex representatives' discussion with audience about past experience of companies and prospects of cooperation with scientific community.



Presented innovation promotion initiative CONINNO (Construction Innovations Academic Circle) that unites the academic community and business.



A novelty at our meeting was a session devoted to the promotion works - focused mainly on the discussion on new and innovative topics of doctoral dissertations. Our younger colleagues will be grateful for some good words showing directions using your years of experience and great scientific achievements.



Next day started with presentation of Prof. Dr. Mladen Radujkovic - the President of the International Project Management Association (IPMA), Dean of Faculty of Civil Engineering at University of Zagreb, Croatia. Mladen Radujkovic presented the Megaproject initiative and main objective of this action. The discussion covered the question how megaprojects can be designed and delivered more effectively to ensure their effective commissioning within the European Union.



Dr. Tomasz Błaszczczyński from Poznan University of Technology presented the research "*Usage of Green Concrete Technology in Civil Engineering*" (authors: T. Błaszczczyński, M. Król). Discussed the possibilities for environmental protection and comprehensive greening concrete industry with use of geopolymers in concrete production.



The join scientific group from Leipzig University of Applied Sciences (Germany) and University Rome Tor Vergata (Italy) presented the research *“Efficient Soil Compactors-Numerical Simulation and Optical High-Speed Measurement as a Development Component for Innovative Equipment Approaches”* (authors: H. Pankrath, M. Barthel, A. Knut, M. Bracciale, R. Thiele).



Mahmoud Hsino the doctoral student from Stanisław Staszic University of Applied Sciences in Piła (Poland) discussed the possibilities to use a phase change material in the preparation of concrete mixes. He presented research *“Reduction of the thermal gradient in concrete mixture in dry and hot climates using Phase Change Materials”* (authors: M. Hsino, J. Paślawski).



Joanna Czaja the doctoral student from AGH University of Science and Technology (Poland) presented the research *"Analysis of factors stimulating and conditioning the application of reverse logistic in construction"* (authors: A. Sobotka, J. Czaja)



Young scientists actively participated in discussions.



Discussions continued in Poster session.





We would like to thank sponsors and everyone who contributed to the organization of colloquium in a relatively short period of time. Special thanks to Dr. Marcin Gajzler, who once again is the Chairman of the Organizing Committee, for exceptional commitment and creativity. As a result, we have not only the perfect program agenda, picturesque resort situated in Wielkopolski National Park, but also the chance to explore Poznan and the surrounding area. Thanks to the members of Scientific Circle ConInno for supporting us in organizing the conference.

Special thanks to far all participants of meeting in Poznań-Puszczykowo. We hope for fruitful continuation of cooperation within cyclic meetings of German-Lithuanian-Polish Colloquium and Meetings of EURO working group Operational Research in Sustainable Development and Civil Engineering.



New methods

During the 30 years of scientific cooperation the members of EWG ORSDCE have created methods for decision support, eg. COPRAS, SWARA, WASPAS, MOORA, MULTIMOORA, ARAS, KEMIRA, MAMVA, COPRAS-G, COPRAS-F, COPRAS-IVIF, ARAS-F, ARAS-G, MOORA-G, MOORA-F, MULTIMOORA-G, MULTIMOORA-F, TOPSIS-M, DEA-IVIF, LINMAP-G, WASPAS-IVIF, MCDM-logarithmic normalization and others.

The table below presents the brief information about methods created and published in year 2015.

Year	Method	Authors	Reference
New methods			
2015	EDAS	Keshavarz Ghorabae, Mehdi Zavadskas, Edmundas Kazimieras Olfat, Laya Zenonas Turskis	Multi-Criteria Inventory Classification Using a New Method of Evaluation Based on Distance from Average Solution (EDAS), <i>INFORMATICA</i> , 2015, Vol. 26, No. 3, 435-451.
New methods based on created earlier			
2015	WASPAS-F	Turskis, Z. Zavadskas, E. K. Antucheviciene, J. Kosareva, N.	A hybrid model based on Fuzzy AHP and Fuzzy WASPAS for construction site selection, <i>International Journal of Computers, Communications & Control</i> , (2015) 10(6): 873-888.
2015	WASPAS-G	Zavadskas, E. K. Turskis, Z. Antucheviciene, J.	Selecting a contractor by using a novel method for multiple attribute analysis: Weighted Aggregated Sum Product Assessment with grey values (WASPAS-G), <i>Studies in Informatics and Control</i> , 2015, 24(2): 141-150.
2015	COPRAS-SVNS	Bausys, R. Zavadskas, E.K. Kaklauskas, A.	Application of neutrosophic set to multicriteria decision making by COPRAS. <i>Econ. Comput. Econ. Cybern. Stud. Res.</i> 2015, 49, 91-106.
2015	WASPAS-SVNS	Zavadskas, E. K. Bausys, R. Lazauskas, M.	Sustainable assessment of alternative sites for the construction of a waste incineration plant by applying WASPAS method with single-valued neutrosophic set, <i>Sustainability</i> , 2015 7: 15923-15936.
2015	MULTIMOORA-IVIF	Zavadskas, E.K. Antucheviciene, J. Hajiagha, S. H. R. Hashemi, S. S.	The Interval-Valued Intuitionistic Fuzzy MULTIMOORA Method for Group Decision Making in Engineering. <i>Mathematical Problems in Engineering</i> , Volume 2015 (2015), Article ID 560690, 13 p.
2015	VIKOR-IVNS	Bausys, R. Zavadskas, E.K.	Multicriteria decision making approach by VIKOR under interval neutrosophic set environment. <i>Econ. Comput. Econ. Cybern. Stud. Res.</i> 2015, 49, in press.
2015	MULTIMOORA-EXT	Stanujkic, D. Zavadskas, K.E. Brauers, W.K.M. Karabasevic, D.	An Extension of the Multimoora Method for Solving Complex Decision-Making Problems based on the Use of Interval-valued Triangular Fuzzy Numbers", <i>Transformations in Business & Economics</i> , Vol. 14, No 2B (35B), (2015), pp.355-375.

Year	Method	Authors	Reference
2016	ELECTRE III-IVIF	Shide Sadat Hashemi, Seyed Hossein Razavi Hajiagha, Edmundas Kazimieras Zavadskas, Hannan Amoozad Mahdiraji	Multicriteria group decision making with ELECTRE III method based on interval-valued intuitionistic fuzzy information. <i>Applied Mathematical Modelling</i> , In Press, Available online 2015
2015	VIKOR-T2F	Ghorabae, M. K. Amiri, M. Sadaghiani, J. S. Zavadskas, E. K.	Multi-Criteria Project Selection Using an Extended VIKOR Method with Interval Type-2 Fuzzy Sets. <i>International Journal of Information Technology & Decision Making</i> , 14, 993 (2015).
2015	WSM modified	Stanujkic, Dragisa Zavadskas, Edmundas Kazimieras	A Modified Weighted Sum Method Based on the Decision- maker's Preferred Levels of Performances. <i>Studies in information and control</i> , Art. 10 – Vol. 24, Iss. 4, 2015
2016	KEMIRA-EXT	N. Kosareva E.K. Zavadskas A. Krylovas S. Dadelo	Personnel Ranking and Selection Problem Solution by Application of KEMIRA Method, <i>INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL</i> , 2016, 11(1):51-66
Hybrid methods			
2015	AHP+ARAS+MOORA+MULTIMOORA	Lazauskas, Marius Kutut, Vladislavas Zavadskas, Edmundas Kazimieras	Multicriteria assessment of unfinished construction projects, <i>Građevinar</i> 67 (2015) 4, 319-328
2015	SWARA-WASPAS-Nash equilibrium	Hashemkhani Zolfani, Sarfaraz Maknoon, Reza Zavadskas, Edmundas Kazimieras	Multiple nash equilibriums and evaluation of strategies. New application of MCDM methods, <i>Journal of Business Economics and Management</i> , 16:2, 290-306.
2016	DEMATEL-ANP-COPRAS-G	Liou, James J.H. Tamošaitienė, Jolanta Zavadskas, Edmundas K. Tzeng, Gwo-Hshiung	New hybrid COPRAS-G MADM Model for improving and selecting suppliers in green supply chain management. <i>International Journal of Production Research</i> , 2015

This year was signified by appearance of new optimization methods belonging to the group of WASPAS (Weighted Aggregates Sum Product Assessment) methods. The article “Recent approaches to extend the crisp WASPAS method into a fuzzy environment in order to deal with uncertain information” by E.K.Zavadskas, Z.Turskis and J.Antuchevičienė is presenting the newly created methods belonging to the group of WASPAS methods.

The paper “Recent development of the new MCDM methods under neutrosophic set environment” by E.K.Zavadskas and R.Baušys presents a brief review of general concepts of neutrosophic set and new applications to multicriteria decision making.

Recent approaches to extend the crisp WASPAS method into a fuzzy environment in order to deal with uncertain information



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*Prof. dr.
Zenonas Turskis*



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Antuchevičienė*

Multi-criteria decision making (MCDM) is applied in different areas of human activities. In the case of existence of at least two possible options, a person has to make a decision and to select the one which best meets his demands based on a number considered criteria. The origins of MCDM methods can be dated over 240 years ago (Franklin 1772). As an individual scientific discipline, it has been widely spreading since the middle of the previous century (Arrow 1951; Simon 1955). The decision making methods have been intensively developed and applied to various engineering and managerial problems in recent decades.

WASPAS

Zavadskas *et al.* (2012) proposed and originally described Weighted Aggregated Sum Product Assessment (WASPAS) method. The method aggregates the Weighted Sum Model (WSM) and the Weighted Product Model (WPM) with the help of originally derived aggregation coefficient, enabling to reach the highest accuracy of multiple attribute estimation of a problem.

Lots of WASPAS method applications for solving MADM problems in engineering and management have been published. WASPAS and ARAS methods were used to evaluate potential alternatives of potential shopping mall locating by Hashemkhani Zolfani *et al.* (2013). Dejus and Antucheviciene (2013) suggested using the WASPAS method for ranking of appropriate alternatives for

occupational safety. Zavadskas *et al.* (2013) presented an application of the method for multi-attribute assessment of public building designs alternatives, while Siozinyte and Antucheviciene (2013) applied the method for assessment of windows' design when upgrading vernacular buildings. Bagocius *et al.* (2014) applied WASPAS method for ranking and selecting the best location for wind farms and assessing the types of wind turbines. While Vafaeipour *et al.* (2014) used the same method of assessment in combination with Step-wise Weight Assessment Ratio Analysis (SWARA) for prioritizing regions and cities for location of solar power plants in the future. Lashgari *et al.* (2014) applied Quantitative Strategic Planning Matrix and WASPAS method that enabled to make reasoned decision in

selecting the best strategies for outsourcing development. Even the method was applied for ranking journals (Zavadskas *et al.* 2014b).

However, usually the benefits of actions in industry are unpredictable, relationships between attributes may be actually unknown. Furthermore, modelling real-world problems with crisp values of attributes under many conditions is inadequate because human judgment and his preferences are often vague and implicit and hardly can be estimated with exact numerical values.

WASPAS-IVIF

The first attempt to extend the method for problems involving uncertainty was presented as WASPAS-IVIF in 2014 (Zavadskas *et al.* 2014a). The aim of the paper was to present a newly developed weighted aggregated sum product assessment method and extended it with interval-valued intuitionistic fuzzy numbers for application in uncertain decision making environment.

Fuzzy sets (Zadeh 1965) are a generalization of conventional sets where the belongingness of an element to a set is shown by a function which is called membership function or degree. The advantages of fuzzy sets in describing uncertainty caused its wide applications in decision making problems. Atanassov (1986) introduced the notion of intuitionistic fuzzy set (IFS) as a generalization of the Zadeh's fuzzy sets. In addition to membership degree of each element in ordinal fuzzy sets, IFS assigns a degree of non-membership to each element. Later, Atanassov and Gargov (1989) extended the interval valued intuitionistic fuzzy sets (IVIFS).

Figure 1 illustrates the proposed group WASPAS-IVIF decision making algorithm.

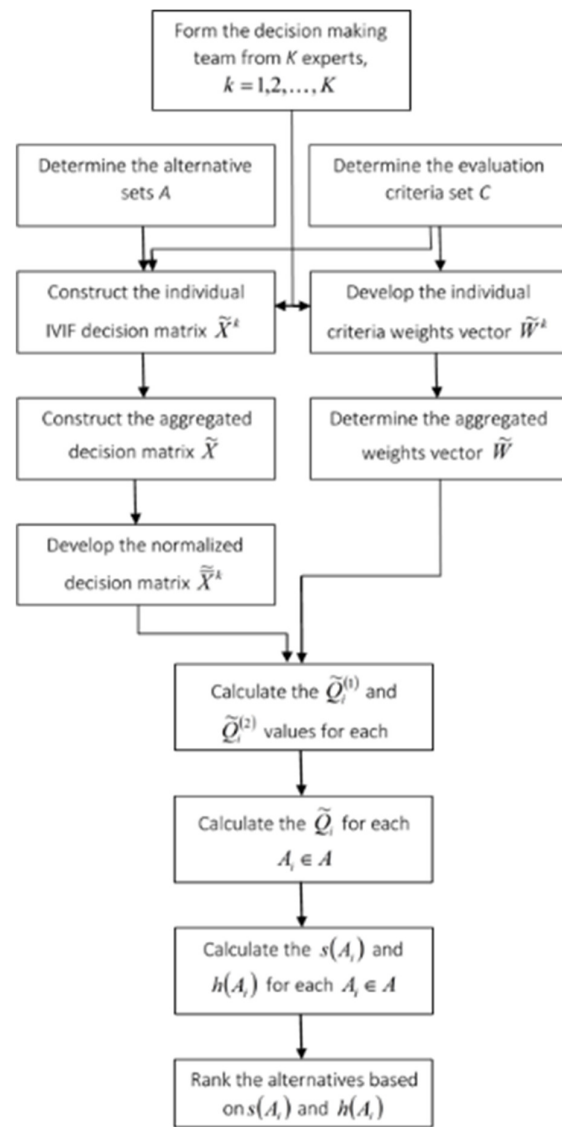


Figure 1. Group WASPAS-IVIF decision making algorithm (Zavadskas *et al.* 2014a)

Suppose a decision making problem in which a set of m alternatives $A_1, A_2, \dots, A_m$ is evaluated based on n criteria $C_1, C_2, \dots, C_n$. The performance or rating of each alternative i in each criterion j is estimated based on IVIFNs. Also, there is a group of K decision makers who will participate in decision process. Consider the k th decision maker, which he/she determines his/her preferences or evaluations regard to alternatives against criteria according to the following matrix $\tilde{X}^k = [\tilde{x}_{ij}^k]$, where $\tilde{x}_{ij}^k = (\mu_{Lij}^k, \mu_{Uij}^k) [v_{Lij}^k, v_{Uij}^k]$ is the IVIFN of alternative i against criterion j .

Another element which must be determined in initial step is developing a set of weights for evaluation criteria, the $\tilde{W}^k = (\tilde{w}_1^k, \tilde{w}_2^k, \dots, \tilde{w}_n^k)$ vector, where $\tilde{w}_j^k = ([\mu_{Lj}^k, \mu_{Uj}^k], [v_{Lj}^k, v_{Uj}^k])$ is the k th expert's judgment on the importance of the j th criterion.

The score and accuracy functions are calculated for $\tilde{Q}_i, i=1,2,\dots,m$ and the final rankings of alternatives are determined based on the descending order of $\tilde{Q}_i, i=1,2,\dots,m$.

Combining the strengths of IVIFS in handling uncertainty with the enhanced accuracy of WASPAS makes the proposed method as a desirable method for multi criteria decision making in real world applications.

WASPAS-G

In the current year Zavadskas et al. (2015a) presented a novel multiple attribute Weighted Aggregated Sum Product Assessment method with the grey attributes scores – WASPAS-G method. The advantages of the proposed technique are based on its capabilities of handling imprecise information due to applied grey relations and capabilities of providing decisions of enhanced accuracy when optimizing weighted aggregated assessment.

Deng (1982) introduced the concepts of grey theory from a grey set by combining concepts of system theory, space theory and control theory. Information can be classified to three groups based on uncertainty level of initial data and named as white numbers, grey numbers and black numbers. Let $\otimes x = [\alpha, \beta] = \{x | \alpha \leq x \leq \beta, \alpha \text{ and } \beta \in R\}$. There $\otimes x$ consists of two real numbers: α is the lower limit and β is the upper limit. Based on the conditions bellow, $\otimes x$ can be classified as follows: if $\alpha = \beta$, then $\otimes x$ is a usual crisp number with complete information and it can

be called the white number; else if $\alpha \rightarrow -\infty$ and $\beta \rightarrow \infty$, then $\otimes x$ contains no meaningful information and it can be called the black number; otherwise $\otimes x = [\alpha, \beta]$ is called the grey number which means and uncertain, incomplete or insufficient information.

To extend the WASPAS method in vague environment with the help of grey numbers, initial decision making matrix should be presented as a grey decision-making matrix. Matrix is composed on the basis of preferences of decision alternatives rated on attributes $\otimes x_{ij}$, where $i = 1, \dots, m$; $j = 1, \dots, n$; m – number of alternatives, n – number of attributes.

Next, instead of working with an uncertain real numbers and applying classical arithmetic operations, a decision maker works with the grey numbers and grey arithmetic. Finally, the grey values of $\otimes Q_i$ are transformed to crisp values by the centre-of-area method.

The decreasing preference order of the alternatives is determined according to the decreasing sequence of Q_i .

The proposed novel method was applied in a case study of evaluation and selection of a right contractor from a set of potential construction contractors.

WASPAS-F

Turskis et al. (2015) proposed a fuzzy multi-attribute performance measurement (MAPM) framework using the merits of both a novel Weighted Aggregated Sum-Product Assessment method with Fuzzy values (WASPAS-F) and Analytical Hierarchy Process (AHP). The object of the study was to select the best shopping centre construction site. A number of conflicting qualitative and quantitative attributes were involved for evaluating alternative construction sites. Because qualitative attributes are accompanied by ambiguities and vagueness,

this makes fuzzy logic a more natural approach to this kind of multi-attribute decision making problems. Fuzzy AHP was applied for assigning weights of the attributes and WASPAS-F method was used to determine the most suitable alternative (Figure 2).

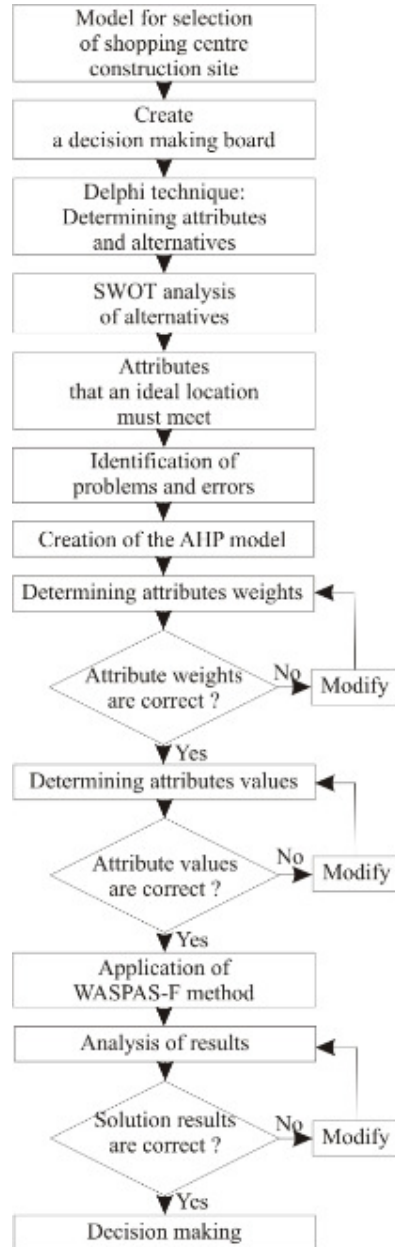


Figure 2. Flowchart of the proposed hybrid approach (Turskis *et al.* 2015)

Based on fuzzy theory (Zadeh 1965), the first step of WASPAS-F is forming of fuzzy decision-making matrix (FDMM). The

performance values $\tilde{x}_{ij}$ and the attributes weights $\tilde{w}_j$ are entries of a DMM. The linguistic ratings are chosen, i.e. the system of attributes as well as the values and initial weights of attributes are determined by experts. Next, fuzzy arithmetic operations are applied. The result of fuzzy performance measurement for each alternative are fuzzy numbers, accordingly the centre-of-area approach is applied for defuzzification.

As a result of the study, the authors found that the proposed method is practical for ranking alternatives with respect to multiple conflicting attributes for the large scale problems.

WASPAS-SVNS

A new extension of WASPAS method, namely WASPAS-SVNS was proposed by Zavadskas *et al.* (2015b) in the current year also. This extension is realized in the framework of the single-valued neutrosophic set that enables to represent and model the indeterminacy explicitly and the functions of the truth-membership, the indeterminacy-membership and the falsity-membership are not related to each other.

Rather new approach named neutrosophic sets have been proposed by Smarandache (1999) recently. These neutrosophic sets allow dealing with “knowledge of neutral thought” and this “neutral” component distinguishes this set from the other approaches that model uncertain phenomena of information. In fact, the neutrosophic sets are a generalization of the fuzzy and intuitionistic fuzzy sets.

In the proposed extension, at first the evaluations concerning the ratings of the alternatives with respect to the attributes and the attribute weights are presented. Neutrosophication of the normalized aggregated decision matrix and the aggregated weight vector is performed. In the

neutrosophication step all crisp initial information is converted into the single valued neutrosophic set. Next, the algebra of the single-valued neutrosophic set for WASPAS algorithm is applied and a joint generalized criteria for the ranking alternatives are determined.

The proposed application deals with the solution of the waste incineration plant siting problem due to the requirements of sustainability factors.

WASPAS with IT2FSs

The WASPAS method is extended for group decision making with interval type-2 fuzzy sets (Keshavarz Ghorabae *et al.* 2015). Also a new approach is proposed to obtain criteria weights using the entropy method. An illustrative example is used to demonstrate the applicability of the proposed method in green supplier selection problems. A comparison and a sensitivity analysis are performed to show the validity and stability of the proposed method.

Type-1 fuzzy sets (Zadeh 1965) have a crisp membership value in $[0, 1]$; However, it is hard to estimate the exact membership function of fuzzy sets in many situations. Zadeh (1975) introduced type-2 fuzzy sets for handling the unsuitability issues of type-1 fuzzy sets in these cases. Type-2 fuzzy sets are three-dimensional and their membership function is defined by a fuzzy set on the interval $[0, 1]$ and described by both primary and secondary membership to provide more degrees of flexibility. Hence, type-2 fuzzy sets are more precise in the modelling of uncertainty compared with type-1 fuzzy sets.

Using IT2FSs gives more degrees of flexibility to the decision-makers to express their preferences in an uncertain environment. In the proposed method, the weights expressed by decision-makers are combined with the weights resulted from the entropy method. More realistic criteria weights for decision-making process can be obtained by using this combination.

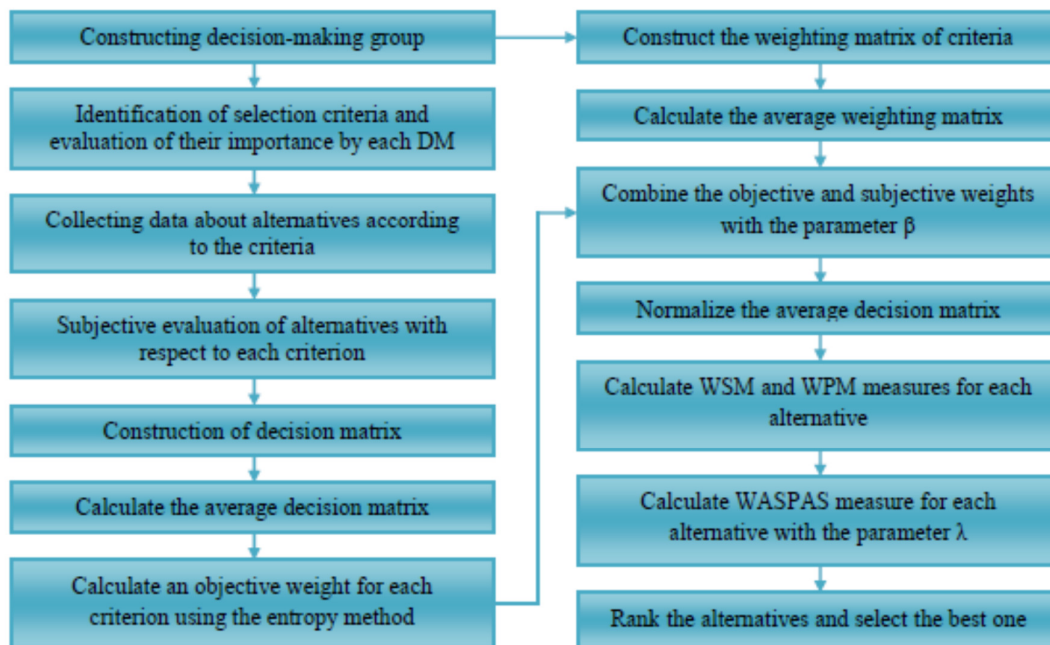


Figure 3. The framework for using the proposed method (Keshavarz Ghorabae *et al.* 2015)

To validate the results, the authors have made a comparison between the proposed method and some existing methods. A sensitivity analysis has also been performed

with different criteria weights and different values of method's parameters to represent the stability of the proposed method. The analysis of the results show that the proposed method has a good efficiency and stability, and is well consistent with the other methods. The framework for using the proposed method is presented in Figure 3.

The proposed method also could be used in the group decision-making under uncertainty that has many applications in industrial problems such as facility location selection, robot selection, project selection, portfolio selection, etc.

The latest applications

The latest applications of WASPAS method cover manufacturing and machining processes (Petkovic *et al.* 2015; Chakraborty *et al.* 2015a, 2015b), also supply chain management (Hashemkhani Zolfani *et al.* 2015).

Further research trends

As for further extensions, the other possible approach could be to apply D numbers (Deng 2012) that were recently proposed to handle uncertain information.

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Recent development of the new MCDM methods under neutrosophic set environment



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During the last decade a lot of the research efforts have been made to incorporate the vagueness of the initial information for the solution of the complex nature practical problems by multi-criteria decision making (MCDM) methods. Although the different types of the fuzzy sets have been introduced and applied to the solution of the MCDM problems, they cannot take into account all sorts of uncertainties that arise in the solution of the real engineering problems. A theory of the neutrosophic sets originally proposed by Smarandache (1999, 2014) allows to deal with “knowledge of neural thought” and this “neutral” component distinct this set from the other approaches that are to model uncertain phenomena of information (Mardani *et al* (2015)). In fact the neutrosophic sets are a generalization of the “fuzzy” and “intuitionistic fuzzy” sets. However, the existing methods governed by fuzzy sets and their particular types are not convenient to solve decision making problem with neutrosophic information. By the logic of the neutrosophic sets each aspect of the problem is represented by the degree of the truth (T), a degree of the indeterminacy (I) and a degree of the falsity (F). In contrast to intuitionistic fuzzy sets where the degree of the uncertainty depends on the degree of membership and the degree of non-membership, by neutrosophic logic the value of the indeterminacy degree is independent of truth and falsity degrees. We present a brief review of general concepts of neutrosophic set (Smarandache (1999)).

Definition 1. Let X be space of the objects and $x \in X$. A neutrosophic set A in X is defined by three functions: truth-membership function $T_A(x)$, an indeterminacy- membership function $I_A(x)$ and falsity-membership function $F_A(x)$. These functions $T_A(x)$, $I_A(x)$ and $F_A(x)$ are defined on real standard or real non-standard subsets of $]0^-, I^+[$. That is $T_A(x): X \rightarrow]0^-, I^+[$, $I_A(x): X \rightarrow]0^-, I^+[$ and $F_A(x): X \rightarrow]0^-, I^+[$. We have no any restriction on the sum of $T_A(x)$, $I_A(x)$ and $F_A(x)$, so $0^- \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3^+$.

Single valued neutrosophic set

An operational algebra of the single valued neutrosophic set (SVNS) has been defined below.

Definition 2. Let X be a universal space of the objects and $x \in X$. A single valued neutrosophic set (SVNS) $\tilde{N} \subset X$ can be expressed as

$$\tilde{N} = \left\{ \langle x, T_{\tilde{N}}(x), I_{\tilde{N}}(x), F_{\tilde{N}}(x) \rangle : x \in X \right\} \quad (1)$$

where $T_{\tilde{N}}(x): X \rightarrow [0,1]$, $I_{\tilde{N}}(x): X \rightarrow [0,1]$ and $F_{\tilde{N}}(x): X \rightarrow [0,1]$ with $0 \leq T_{\tilde{N}}(x) + I_{\tilde{N}}(x) + F_{\tilde{N}}(x) \leq 3$ or all $x \in X$. The values $T_{\tilde{N}}(x)$, $I_{\tilde{N}}(x)$ and $F_{\tilde{N}}(x)$ correspond to truth-membership degree, the indeterminacy-membership degree and the falsity-membership degree of x to $\tilde{N}$, respectively. For the case when X consists of the single element, $\tilde{N}$ is called a single valued neutrosophic number. For the sake of the simplicity, a single valued neutrosophic number is expressed by $\tilde{N}_A = (t_A, i_A, f_A)$ where $t_A, i_A, f_A \in [0,1]$ and $0 \leq t_A + i_A + f_A \leq 3$.

Definition 3. If $\tilde{N}_1 = (t_1, i_1, f_1)$ and $\tilde{N}_2 = (t_2, i_2, f_2)$ are two single valued neutrosophic numbers (SVNN), then the summation between $\tilde{N}_1$ and $\tilde{N}_2$ can be expressed as follows

$$\tilde{N}_1 \oplus \tilde{N}_2 = (t_1 + t_2 - t_1 t_2, i_1 i_2, f_1 f_2) \quad (2)$$

Definition 4. If $\tilde{N}_1 = (t_1, i_1, f_1)$ and $\tilde{N}_2 = (t_2, i_2, f_2)$ are two single valued neutrosophic numbers, then multiplication between $\tilde{N}_1$ and $\tilde{N}_2$ can be expressed as follows

$$\tilde{N}_1 \otimes \tilde{N}_2 = (t_1 t_2, i_1 + i_2 - i_1 i_2, f_1 + f_2 - f_1 f_2) \quad (3)$$

Definition 5. If $\tilde{N}_1 = (t_1, i_1, f_1)$ is a single valued neutrosophic number and $\lambda \in \mathbb{R}$ is an arbitrary positive real number then

$$\lambda \tilde{N}_1 = (1 - (1 - t_1)^\lambda, i_1^\lambda, f_1^\lambda), \lambda > 0 \quad (4)$$

Definition 6. If $A = (A_1, A_2, \dots, A_n)$ and $B = (B_1, B_2, \dots, B_n)$ are two single valued neutrosophic sets, then separation measure between A and B applying the normalized Euclidian distance can be expressed as follows

$$q_n(A, B) = \sqrt{\frac{1}{3n} \sum_{i=1}^n (t_A(x_i) - t_B(x_i))^2 + (i_A(x_i) - i_B(x_i))^2 + (f_A(x_i) - f_B(x_i))^2} \quad (i = 1, 2, \dots, n) \quad (5)$$

Definition 7. If $\tilde{N}_A = (t_A, i_A, f_A)$ is a single valued neutrosophic number, a score function is mapped $\tilde{N}_A$ into the single crisp output $S(\tilde{N}_A)$ as follows

$$S(\tilde{N}_A) = \frac{3 + t_A - 2i_A - f_A}{4} \quad (6)$$

Where $S(\tilde{N}_A) \in [0,1]$. This score function allows us to have the results in the same interval as we deal with single valued neutrosophic numbers.

Definition 8. Let $\tilde{N}_1$ and $\tilde{N}_2$ be any two SVNNs. Therefore,

If $S(\tilde{N}_1) < S(\tilde{N}_2)$ then $\tilde{N}_1$ is smaller than $\tilde{N}_2$, $\tilde{N}_1 < \tilde{N}_2$.

Interval-valued neutrosophic set

Definition 9. Let X be a universal space of the generic objects and $x \in X$. An interval-valued neutrosophic set (IVNS) $N \subset X$ can be expressed as

$$N = \{ \langle x, T_N(x), I_N(x), F_N(x) \rangle : x \in X \} \quad (7)$$

where $T_N(x): X \rightarrow [0,1]$, $I_N(x): X \rightarrow [0,1]$ and $F_N(x): X \rightarrow [0,1]$ with $0 \leq T_N(x) + I_N(x) + F_N(x) \leq 3$ or all $x \in X$. The values $T_N(x)$, $I_N(x)$ and $F_N(x)$ correspond to truth-membership degree function, the indeterminacy-membership degree function and the falsity-membership degree function of x to N , respectively. For the case when X consists of the interval elements, these functions can be expressed as $T_N(x) = [\inf T_N(x), \sup T_N(x)] \subseteq [0,1]$, $I_N(x) = [\inf I_N(x), \sup I_N(x)] \subseteq [0,1]$, $F_N(x) = [\inf F_N(x), \sup F_N(x)] \subseteq [0,1]$ and $0 \leq \sup T_N(x) + \sup I_N(x) + \sup F_N(x) \leq 3, x \in X$.

Definition 10. If $N_1 = \langle [\inf T_{N1}, \sup T_{N1}], [\inf I_{N1}, \sup I_{N1}], [\inf F_{N1}, \sup F_{N1}] \rangle$ and $N_2 = \langle [\inf T_{N2}, \sup T_{N2}], [\inf I_{N2}, \sup I_{N2}], [\inf F_{N2}, \sup F_{N2}] \rangle$ are two interval-valued neutrosophic numbers (IVNN), then N_1 is contained in the other neutrosophic element N_2 , $N_1 \subseteq N_2$ if and only if

$$\begin{aligned} \inf T_{N1} &\leq \inf T_{N2}, \sup T_{N1} \leq \sup T_{N2}, \\ \inf I_{N1} &\geq \inf I_{N2}, \sup I_{N1} \geq \sup I_{N2}, \text{ for any } x \in X \\ \inf F_{N1} &\geq \inf F_{N2}, \sup F_{N1} \geq \sup F_{N2}, \end{aligned} \quad (8)$$

Definition 11. Two IVNNs N_1 and N_2 are equal, expressed as $N_1 = N_2$, if and only if $N_1 \subseteq N_2$ and $N_1 \supseteq N_2$.

Definition 12. Comparison of the interval-valued neutrosophic numbers is performed applying the score, accuracy and certainty functions. For the interval-valued neutrosophic number $N_1 = \langle [\inf T_{N1}, \sup T_{N1}], [\inf I_{N1}, \sup I_{N1}], [\inf F_{N1}, \sup F_{N1}] \rangle$ these functions have the expressions

$$\begin{aligned} s(N_1) &= \left[\inf T_{N1} + 1 - \sup I_{N1} + 1 - \sup F_{N1}, \right. \\ &\quad \left. \sup T_{N1} + 1 - \inf I_{N1} + 1 - \inf F_{N1} \right] \\ a(N_1) &= \left[\min\{\inf T_{N1} - \inf F_{N1}, \sup T_{N1} - \sup F_{N1}\}, \right. \\ &\quad \left. \max\{\inf T_{N1} - \inf F_{N1}, \sup T_{N1} - \sup F_{N1}\} \right] \\ c(N_1) &= [\inf T_{N1}, \sup T_{N1}] \end{aligned} \quad (9)$$

where $s(N_1)$, $a(N_1)$ and $c(N_1)$ denotes the score, accuracy and certainty functions of the IVNN N_1 , respectively.

Definition 13. Let N_1 and N_2 be two IVNNs, then the comparison of these two IVNNs can be performed as follows:

- 1) If $p(s(N_1) \geq s(N_2)) > 0.5$, then N_1 is greater than N_2 or in other words, N_1 is superior to N_2 and that can be expressed as $N_1 \succ N_2$.
- 2) If $p(s(N_1) \geq s(N_2)) = 0.5$ and $p(a(N_1) \geq a(N_2)) > 0.5$, then N_1 is greater than N_2 or in other words, N_1 is superior to N_2 and that can be expressed as $N_1 \succ N_2$.
- 3) If $p(s(N_1) \geq s(N_2)) = 0.5$, $p(a(N_1) \geq a(N_2)) = 0.5$ and $p(c(N_1) \geq c(N_2)) > 0.5$, then N_1 is greater than N_2 or in other words, N_1 is superior to N_2 and that can be expressed as $N_1 \succ N_2$.

4) If $p(s(N_1) \geq s(N_2)) = 0.5$, $p(a(N_1) \geq a(N_2)) = 0.5$ and $p(c(N_1) \geq c(N_2)) = 0.5$, then N_1 is equal to N_2 or in other words, N_1 is indifferent to N_2 and that can be expressed as $N_1 \sim N_2$.

Definition 14. The degree of the possibility of the score function is calculated by following equation

$$p(s(N_1) \geq s(N_2)) = \max \left\{ 1 - \max \left(\frac{\sup(s(N_2)) - \inf(s(N_1))}{l_{N1} + l_{N2}}, 0 \right), 0 \right\} \quad (10)$$

where $l_{N1} = \sup(s(N_1)) - \inf(s(N_1))$ and $l_{N2} = \sup(s(N_2)) - \inf(s(N_2))$. The degrees of the possibility for the accuracy and certainty functions are determined in the same way.

MCDM approaches

All extensions were constructed by the application of the neutrosophic sets to model the information for the decision making problem. The general framework for the information processing of the proposed MCDM method can be illustrated as presented in Fig.1.

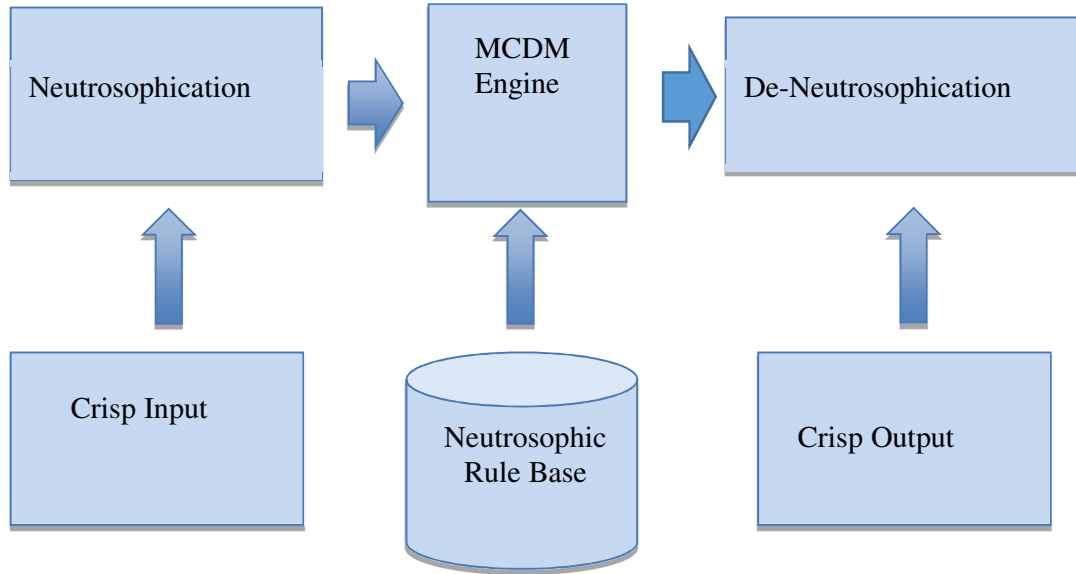


Figure 1. Information processing flow for MCDM with neutrosophic set

COPRAS with a single value neutrosophic set (COPRAS-SVNS)

Multicriteria decision making method with single value neutrosophic sets (SVNS), namely COPRAS-SVNS, has been proposed by Bausys et al (2015a). Determination of the score value of each alternative Q_i is performed. At the beginning the score values are calculated from the aggregated values for benefit and the cost $S(P_{+i})$ and $S(P_{-i})$ applying Eq.(13). The score values of the alternatives can be expressed as

$$Q_i = S(P_{+i}) + \frac{\left(S(P_{-min}) \sum_{i=1}^{L_{min}} S(P_{-i}) \right)}{\left(S(P_{-min}) \sum_{i=1}^{L_{min}} \frac{S(P_{-min})}{S(P_{-i})} \right)} \quad (11)$$

Step 10. Determine optimality criterion K for the alternatives:

$$K = \max_i Q_i; i = 1, 2, \dots, m \quad (12)$$

VIKOR method under environment of an interval-valued neutrosophic set (VIKOR-IVNS)

Bausys and Zavadskas (2015c) propose a novel extension of VIKOR method for the solution of the multicriteria decision making problems, namely VIKOR-IVNS. The main ideas of the proposed extension of VIKOR method can be expressed as follows. Determine the values S_j and R_j ; $j = 1, 2, \dots, m$ applying the following equations

$$\inf S_j = \sum_{i \in L_{\max}} \inf(s(w_i)) \frac{x_i^+ - \sup(s(\tilde{x}_{ij}))}{x_i^+ - x_i^-} + \sum_{i \in L_{\min}} \inf(s(w_i)) \frac{\inf(s(\tilde{x}_{ij})) - x_i^+}{x_i^- - x_i^+} \quad (13)$$

$$\sup S_j = \sum_{i \in L_{\max}} \sup(s(w_i)) \frac{x_i^+ - \inf(s(\tilde{x}_{ij}))}{x_i^+ - x_i^-} + \sum_{i \in L_{\min}} \sup(s(w_i)) \frac{\sup(s(\tilde{x}_{ij})) - x_i^+}{x_i^- - x_i^+} \quad (14)$$

$$\inf R_j = \max \left\{ \begin{array}{l} \inf(s(w_i)) \frac{x_i^+ - \sup(s(\tilde{x}_{ij}))}{x_i^+ - x_i^-} | i \in L_{\max}, \\ \inf(s(w_i)) \frac{\inf(s(\tilde{x}_{ij})) - x_i^+}{x_i^- - x_i^+} | i \in L_{\min} \end{array} \right\} \quad (15)$$

$$\sup R_j = \max \left\{ \begin{array}{l} \sup(s(w_i)) \frac{x_i^+ - \inf(s(\tilde{x}_{ij}))}{x_i^+ - x_i^-} | i \in L_{\max}, \\ \sup(s(w_i)) \frac{\sup(s(\tilde{x}_{ij})) - x_i^+}{x_i^- - x_i^+} | i \in L_{\min} \end{array} \right\} \quad (16)$$

Calculate the Q_j values for $j = 1, 2, \dots, m$ applying following equations

$$\inf Q_j = v \frac{(\inf S_j - S^+)}{(S^- - S^+)} + \frac{(1-v)(\inf R_j - R^+)}{(R^- - R^+)} \quad (17)$$

$$\sup Q_j = v \frac{(\sup S_j - S^+)}{(S^- - S^+)} + \frac{(1-v)(\sup R_j - R^+)}{(R^- - R^+)} \quad (18)$$

where

$$S^+ = \min_j (\inf S_j), S^- = \max_j (\sup S_j) \quad (19)$$

$$R^+ = \min_j (\inf R_j), R^- = \max_j (\sup R_j) \quad (20)$$

According to VIKOR method, the best alternative must has the minimum Q_j and it can be chosen as a compromise solution. For the selection of the minimum Q_j the rules, presented in the definition 6, are applied.

An extension of the WASPAS method with single-valued neutrosophic set (WASPAS-SVNS)

Following the WASPAS-SVNS approach, the sum of the total relative importance of the alternative i is calculated by the following equation

$$\tilde{Q}_i^{(1)} = \sum_{j=1}^{L_{max}} \tilde{x}_{+ij}^n \cdot w_{+j}^n + \left(\sum_{j=1}^{L_{min}} \tilde{x}_{-ij}^n \cdot w_{-j}^n \right)^c \quad (21)$$

where $\tilde{x}_{+ij}^n$ and w_{+j}^n values correspond to the criteria to be maximized and $\tilde{x}_{-ij}^n$ and w_{-j}^n values correspond to the criteria to be minimized. The second term of the summation consists of the complementary neutrosophic numbers.

The second criteria of the WASPAS-SVNS methodology is determined applying the framework of the product total relative importance of the alternative i is calculated by the following equation

$$\tilde{Q}_i^{(2)} = \prod_{j=1}^{L_{max}} \left(\tilde{x}_{+ij}^n \right)^{w_{+j}^n} \cdot \left(\prod_{j=1}^{L_{min}} \left(\tilde{x}_{-ij}^n \right)^{w_{-j}^n} \right)^c \quad (22)$$

The description of the terms of this equation corresponds to the definition presented at the previous step. A joint generalized criteria for the ranking alternatives by the proposed WASPAS-SVNS approach is determined as follows

$$\tilde{Q}_i = 0.5\tilde{Q}_i^{(1)} + 0.5\tilde{Q}_i^{(2)} \quad (23)$$

In the last step, the score function $S(\tilde{Q}_i)$ is determined for $i=1, 2, \dots, m$ and the final rankings of the alternatives are calculated considering the descending order of the $\tilde{Q}_i, i=1, 2, \dots, m$.

Further research trends

As for further extensions, the other possible approach could be to apply another models of the neutrosophic sets that were recently proposed to handle uncertain information.

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International projects in process

No.	Programme	Project	Short code	Date from - to	Responsible person (project manager)
1	Life Long Learning (LLP)	Collaborative Action towards Disaster Resilience Education	CADRE	2013-2016	Prof. Habil. Dr. Artūras Kaklauskas
2	Life Long Learning (LLP)	Collaborative Reformation of Curricula on Resilience Management with Intelligent Systems in Open Source and Augmented Reality	RESINT	2013-2015	Prof. Habil. Dr. Artūras Kaklauskas
3	Other (academic)	Reformation of the Curricula on Built Environment in the Eastern Neighbouring Area	CEN EAST	2012-2015	Prof. Habil. Dr. Artūras Kaklauskas
4	Intelligent Energy Europe (IEE)	Initiative to boost continuing or further education and training of craftsmen and other on-site construction workers and systems installers in the building sector http://www.buildupskills.eu/	Build Up Skills ENERGOTRAIN	2014-2016	Assoc Prof Dr Tatjana Vilutienė
5	Leonardo Da Vinci	Postgraduate European Common Studies in Construction Project Management http://mbaic.il.pw.edu.pl/	MBAIC	2013-2015	Assoc.prof. Dr Arūnas Barvidas

The results of LDV Project "MBAIC - Postgraduate European Common Studies in Construction Project Management"

Paweł Olaf Nowak, Tatjana Vilutienė

The Leonardo da Vinci programme, financed by the European Union, encourages international projects focused on education and recognition of professional qualifications. The project "MBA in Construction - Postgraduate European Common Studies in Construction Project Management (MBAIC)" (Nr: 2013-1-PL1-LEO05-37822) aimed to create common postgraduate studies at the Master of Science level among several European universities (Warsaw University of Technology, Vilnius Gediminas Technical University, Technical University of Valencia, Poznan University of Technology, and the University of Minho) supported by professional associations (the Chartered Institute of Building and the Polish Association of Building Managers). This project deepens the ideas of Directive 89/48/EWG, which will lead to the creation of a proper European system of comparison, certification and mutual recognition of managerial qualifications in construction. The project is based on several successfully finished projects which enabled the creation of a set of nineteen construction managers' manuals. As a result of this project, new postgraduate studies for construction managers created by constituting a common platform for managerial knowledge. Results of the project will improve didactic process and qualifications recognition of European Union managers in construction.

The MBAIC postgraduate studies based on the Construction Managers' Library – a set of books related to the wide area of management in construction. The books were created within the Leonardo da Vinci (LdV) projects No: PL/06/B/F/PP/174014; 2009-1-PL1-LEO05-05016 and 2011-1-PL1-LEO05-19888, entitled: "COMMON LEARNING OUTCOME FOR EUROPEAN MANAGERS IN CONSTRUCTION, phases I, II and III – CLOEMC)" and TTC Project titled "Strengthening of European Union funds absorption capacity for infrastructure construction projects" (No: 2010 - 1 - PL1 - LEO05 - 11469).

The didactic material for new MBAIC study program consists of the following modules:

- IT support for construction projects
- Cost and time management in construction
- Site Management
- Risk and Value Management
- Management of Infrastructure Projects
- Human Resources Management in Construction
- Chosen issues of Construction Project Management
- H&S, Environmental and Quality Management
- Procurement and Marketing
- Legal Aspects in Construction

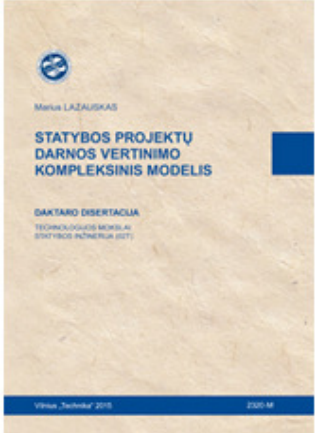
Studies methodology foresee to use MOODLE platform for distance and blended learning (see figure). The training techniques described in organizational scheme of MBAIC study programme include presentations conducted by the trainer/tutor or a resource specialist, analysis of case studies or real-life situations and discussions, simulations of real-life situations and small group discussions to share experiences and ideas or problem solutions.

The teaching and learning methodology created assuming that study programme fills an immediate need and is therefore highly participatory. Adult learning principles include self-directed, experiential learning to ensure that participants and the trainer will learn from each other. Time is allowed for reflection and corrective feedback creating comfortable and mutually respectful environment between trainer/tutor and participants.

PhD Dissertations defended during 2015

Name of doctoral student	Title of dissertation	Year	Scientific supervisor
Marius Lazauskas	Complex Model for Sustainability Assessment of Construction Projects	2015	Prof. Dr. Habil. Edmundas Kazimieras Zavadskas
Dovilė Lazauskaite	Quality Analysis and Integrated Assessment of Residential Environment of Developing Suburban Settlements	2015	Prof. Dr. Marija Burinskienė
Rasa Džiūgaitė-Tumėnienė	Integrated Assessment of the Energy Supply for a Low-Energy House	2015	Scientific supervisor: Prof. Dr. Habil. Vidmantas Jankauskas Scientific consultant: Prof. Dr. Habil. Vytautas Martinaitis
Galina Ševčenko	Risk Management of Investment Decisions in Construction	2015	Scientific consultant: Prof. Dr. Habil. Leonas Ustinovičius
Lina Pečiūrė	Human Resource management in Emergency Situations	2015	Prof. Dr. Habil. Artūras Kaklauskas

Short review of defended dissertations

	Complex Model for Sustainability Assessment of Construction Projects Marius Lazauskas 2015 Scientific supervisor: Prof. Dr. Habil. Edmundas Kazimieras Zavadskas
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Research object. The research object is to assess construction projects applying complex sustainability principles.

Aim and Tasks of the Work.

The main aim of the thesis is to propose complex model to be applied to the assessment of justification sustainability of a construction project and the algorithm for its practical application.

To achieve the aim of the thesis, the following objectives were formulated:

1. To analyze construction project implementation conditions and prospects of market environment in the context of sustainable development.
2. To determine factors defining and predetermining the efficiency of construction projects at the early project idea stage.
3. To identify sustainable development problems in construction and propose index systems to be applied for the formulation of complex assessment model.
4. To develop complex model to be applied for the assessment of construction project sustainability based on sustainable development principles.
5. Check theoretical complex assessment model to be applied for the assessment of construction project sustainability in practice.

Research methodology.

Analysis of statistical data provided by various institutions, execution of physical measurements and calculations, collection of information provided in printed information sources have been performed in the course of development of formulated index systems. In order to justify practical application of

the complex multistage decision making model algorithms the well known multi-objective assessment methods and their combinations were applied.

Defended Statements.

1. Complex assessment of construction project sustainability provides opportunities to identify and realize interests of constructors, regulatory authorities and users fulfilling principles of sustainable development.
2. When assessing the construction project efficiency formulated on the basis of extensive data and stated objectives it is useful to apply validated and easily processable systems of combinations of multi-objective assessment methods.
3. Developed Complex Multicriteria Model enables identification of the efficiency of a project to be implemented within its development environment.

The scope of the scientific work.

The thesis comprises an introduction, three chapters, general conclusions, list of literature, resources and scientific publications of the author on the topic of dissertation, abstract in English and the annexes.

Approval of the thesis.

9 scientific articles were published on the topic of the thesis: five in scientific journals included into Thomson Reuters ISI Web of Science, two in conference proceedings of Lithuanian conferences. Findings of the thesis were presented at 3 scientific conferences.

Practical value.

Research findings may be useful for performing entities involved in construction activities and staining after business expansion or development of new activities. Complex assessment algorithm developed in the course of the research could be used as a tool for assessing the construction projects and providing particular opportunities related to the modeling of urban development strategies. In case of the practical application of the complex assessment model, the policy of public administration entities, related to the development of urban and other territories, could be formed, defining the potential development strategies.



Quality Analysis and Integrated Assessment of Residential Environment of Developing Suburban Settlements

Dovilė Lazauskaitė
2015

Scientific supervisor: Prof. Dr. Marija Burinskienė

Research object. The quality of the suburban rural residential areas in terms of its functionality, spatial organization (living environment) and its contribution while formatting the network of suburban rural areas.

Aim and Tasks of the Work.

The aim – to improve general quality of the plans for urban and rural residential areas including the assessment of interaction level between the urban and rural areas systems.

To achieve the aim of the thesis, the following objectives were formulated:

1. Overview the connection between cities and its rural suburban settlements areas as they are influencing both one and the other functionality.
2. Define the concept of suburban residential environment including the connective components of rural and urban interaction. While measuring the quality of suburban residential environment, to evaluate the impact of connections.

3. To perform the analysis of internal migration of population between rural and urban settlements in the influence area of Lithuanian metropolitan cities.
4. Identify the factors both objective and subjective that are affecting the interaction between urban and rural residential areas and to develop the conceptual model of integrated assessment.
5. Furthermore, a conceptual model should be applied to rural residential areas which are located next to major Lithuanian cities. The results of the quality of expansion in residential areas should be presented together with the form of possible future scenarios.

Research methodology.

The basic research methods were used in this study: theoretical, statistical, path analysis, experiential evaluation, multicriteria decision support method. Internal migration of the residents and its causes were analysed using statistical methods. The path analysis was used in order to identify the key factors which are related to the object of this study. A rational qualitative expansion was created with a help of multicriteria decision support method and was compared with current demographic trends based on expansion of residential rural areas in suburbs.

Defended Statements.

1. Cities and rural residential areas are not separate areas; they operate jointly in a complex socio-economic and in structural system of residential areas. Any critical change of the above mentioned systems may be crucial for the functioning of the other system.
2. The preparation of the general plans in Lithuania would improve if the influence assessment of the interaction between cities and rural areas systems had been included into their content.

The scope of the scientific work.

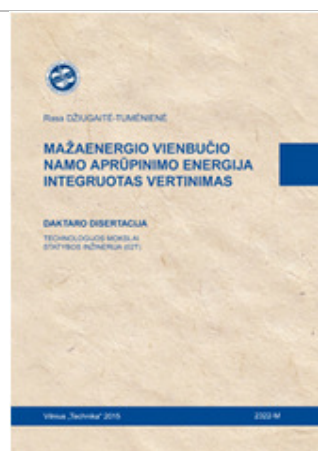
Doctoral theses consists of introduction, three chapters, references, list of publications by the author on the topic of the dissertation, summary in Lithuanian.

Approval of the thesis.

The author of this dissertation has written ten scientific articles about the results of this research. Two of them were published in scientific journals which are refereed in Thomson Reuters Web of Knowledge (ISI Web of Science) database; another two were published in international conferences' – publications refereed in Thomson Routers database Proceedings; two articles in other international databases of scientific publications and four were published in other scientific publications.

Practical value.

According to the obtained research finding the author of the present research is trying to convey a representative picture of development trends in contemporary largest Lithuanian cities' districts, and propose the future development instrument for suburban rural settlements that reflects place-based assets and the perceptions of individuals (both potential residents and planners of these settlements).



Integrated Assessment of the Energy Supply for a Low-Energy House

Rasa Džiūgaitė-Tumėnienė
2015

Scientific supervisor: Prof. Dr. Habil. Vidmantas Jankauskas
Scientific consultant: Prof. Dr. Habil. Vytautas Martinaitis

Research object. The object of this study is an energy supply of a low-energy house.

Aim and Tasks of the Work.

This study aims at establishing an integrated assessment model for an energy supply system of a low-energy single family house which would allow determining a rational solution in terms of quantitative and qualitative criteria.

In order to reach the aim of this study, the following tasks have been set out:

1. To overview the modelling and optimisation methods of building energy demand, energy supply systems and integrated renewable energy technologies, applied in scientific studies.
2. To compile an integrated assessment model of a low-energy building energy supply system (hereinafter – BESS) which would allow determining a rational solution in terms of energy, ecological, economic, comfort and technical functionality (which encompasses system maintenance, exploitation, adjustment possibilities and complexity) criteria.
3. To perform energy demand modelling for low-energy single family house variants, conditioned by different passive measures of energy efficiency, and to determine the main factors that influence the energy performance of a building.
4. To perform the modelling of selected building energy supply systems, comprised of different energy generation (transformation) technologies and to provide systemic analysis results for each BESS.
5. To use the compiled model to perform the multi-criteria assessment of building energy supply systems and to determine a rational system in terms of energy, ecological, economic, comfort and functionality criteria.
6. To assess the reliability of a rational solution in terms of variation in significance values of criteria and to determine the influence of the most critical criterion over the final solution.

Research methodology.

In order to model the energy demand of building variants, DesignBuilder modelling tool is used in this study. PolySun modelling tool is used for modelling energy supply systems of selected buildings; derived results are processed using systemic analysis. This analysis allows determining the interrelations between every BESS subsystem and its elements. MATLAB and MS Excel are used to process the output data of modelling tools and to analyse the results.

Multi-criteria decision making method WASPAS that allows assessing the examined alternatives and making a rational decision in terms of selected assessment criteria is used in order to assess the energy supply system of a building.

In order to determine the reliability of a rational solution, a sensitivity analysis is performed; its goal is to determine whether the solution remains the same if the significance values of criteria are changed and which criterion is the most critical, i.e. alters the arrangement of combination ranks. To perform the sensitivity analysis, the imitation Monte Carlo method, based on statistical modelling as well as statistical analysis of samples of derived results (the significance values of criteria).

Defended Statements.

1. Integral-holistic assessment of a building and its energy supply system that encompasses combinations of modelling tools and optimisation algorithms allows fulfilling requirements for high efficiency buildings.
2. The compiled model of integrated BESS assessment allows performing a comprehensive analysis of building energy demand and energy supply systems as well as determining a rational solution on the basis of selected assessment criteria – energy efficiency, environmental impact, economic, comfort and functionality.
3. Selecting a rational BESS has the most influence over the energy performance of a building due to efficiency measures of passive energy consumption, applied to building envelopes leading to insignificant decrease of primary energy and CO₂ emissions in the total energy balance.
4. A low-energy single family building located in a cold climate zone may achieve a 60% utilisation share of renewable energy resources (hereinafter – RER) if biofuel energy technologies are used to ensure the thermal demand.
5. The environmental impact may be reduced to 3 kgCO₂/m² and RER utilisation may amount to 97 % in the total building energy consumption balance if biofuel and solar energy technologies are selected in order to ensure the energy demand of the building.
6. The application of multi-criteria decision making method leads to the most critical criterion that alters the final rank of alternative priorities influencing the reliability of a rational solution.

The scope of the scientific work.

The dissertation consists of the introduction, 3 chapters, conclusions, a reference list, a list of publications and annexes. The volume of this dissertation is 146 pages, 34 figures, 26 tables and 5 annexes. 190 references have been used.

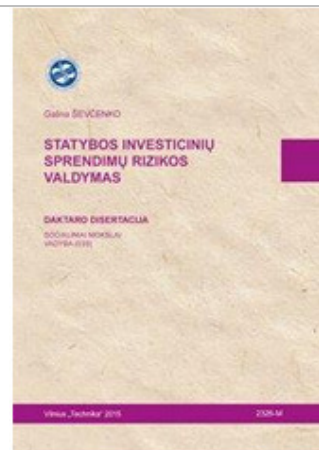
Approval of the thesis.

9 scientific articles have been published on the topic of this dissertation: one in a science journal that has been included in the ISI Web of Science list; two in science journals that have been included in

databases approved by the SCL; five in the reviewed material of an international conference; one in the material of a national conference. The results of research performed in the dissertation were disclosed in five scientific conferences.

Practical value.

The model of integrated assessment proposed by this study would enable to select a rational energy supply system in the stage of building planning after possible passive and active measures of energy consumption efficiency as well as renewable energy technologies are assessed. The algorithm of a model is described in the environment of MATLAB software that has a result output to MS Excel program. Thus, this model may be used by a consumer who wants to perform a comprehensive analysis as well as multi-criteria assessment of the energy demand of a building and alternative energy supply systems.



Risk Management of Investment Decisions in Construction

Galina Ševčenko
2015

Scientific consultant: Prof. Dr. Habil. Leonas Ustinovičius

Research object. The object of study – the risk of construction investment decisions.

Aim and Tasks of the Work.

Create construction investment solutions for risk assessment and management model based on verbal analysis, construction investment solutions to improve efficiency.

In order to achieve the objective the following objectives are formulated:

1. To overview the risk analysis scientists research of all countries of the world.
2. To perform the analysis of meanings and definitions of qualitative and quantitative risk.
3. To overview multipurpose decision-making methods and their application to the problem in question.
4. To perform analysis of the verbal analysis theory and evaluation of its application possibilities.
5. To create the risk measuring mathematical and verbal method, the practical implementation of which would improve the construction investment decision-making efficiency.
6. To develop an integrated theoretical model to the construction investment decision risk assessment and management.
7. To adapt the developed method to construction companies investment challenges.
8. To provide theoretical assumptions for the framework of businesses and projects verbal risk assessment decision-making.

Research methodology.

The basis of the research methodology will be an integrated approach to the knowledge of the subject and its elements: Risks, as the process of examination; Objects, that could be effected by potential risk and the response functions and their interaction with the issued risk characteristics; Methods, applicable to quantitative and qualitative, multi criteria/ multipurpose measurements and economic evaluation; Evolution and SPS technologies, allowing computers to solve complex evaluation and management tasks.

Defended Statements.

1. The nature of risk basis has a qualitative (verbal) meaning.
2. The risk assessment and management classification, sources identification, evaluation of the consequences and systemic actions to reduce their impact are the most important construction investment decision-making stage.

3. The investment decisions risk assessment in times of uncertainty can be improved by verbal analysis methodology that allows to include the indicators with non-quantitative equivalent and to make decisions based on more complete and accurate information.

4. The CLARA method is adapted to meet risk assessment challenges. The uniqueness of the method expresses the opportunity to assess the indicators expressed in qualitatively (verbal) values.

5. Complex construction investment decision risk assessment and management, integrated into the company's investment decision-making and management leads to more efficient operational solutions.

The scope of the scientific work.

The dissertation consists of introduction, 3 chapters, general conclusions, references, list of authors publications and 10 annexes, 44 figures, 9 tables, 14 formulas, 235 references are included in the dissertation.

Approval of the thesis.

The main research results are published in 23 scientific publications. Three refereed database of Thomson Reuters Web of Knowledge (ISI Web of Science); 6 – Conference Paper ISI Proceedings, 9 – other articles in peer-reviewed journals, 5 – papers present work conference publications.

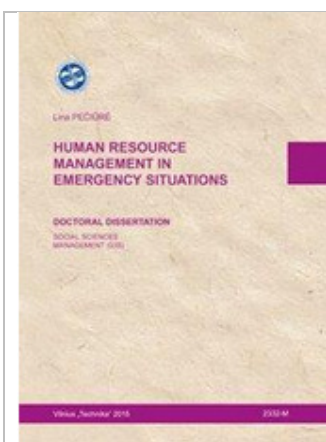
Practical value.

Dissertation research results should be used by all the parties of interest of the project (investors, designers, contractors, users and others).

The developed theoretical model and methodology described in detail allow all project participants to perform an analysis to determine the precise resource requirements, to provide the ability to compare the alternatives, to select, develop and manage the best ones. The sample of the practical implementation of the methodology and its results are proposed.

Developed methodology describes the carried out actions in details that need to be taken in order to solve the challenges of investment in a time of uncertainty. More accurate project investment risk assessment and specific management tools system application reduce the additional costs and barriers in case of uncertainty.

The authors of the research results were partially implemented in the "Improvement of the Quality Management System in the Construction Company "(Agreement No. G - 60/07) project under the order of an entity, research and project were funded by the Lithuanian State Science and Studies Foundation. One Master's dissertation and 7 bachelor degree thesis of investment project risk management topics were successfully written under the Author's counselling. The results confirm the relevance of the existing problem.



Human Resource management in Emergency Situations

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Research object. The object of the research is the whole built environment's resilience management life cycle including the stakeholders participating in emergency situations.

Aim and Tasks of the Work.

The main aim of this research is to increase the efficiency of a human resource management in emergency situations with the help of the suggested model, system and multiple criteria method of analysis.

The objectives of the thesis are:

1. To develop a model for complexly analysing a human resource management in emergency situations.
2. To present a quantitative analysis and a conceptual analysis of a built environment's resilience management life cycle, the parties involved in it and its environmental affects.
3. To apply the methods for complexly determining criteria weights by considering their quantitative and qualitative characteristics, for multiple criteria complex analysis with a proportional evaluation of the human resource management in emergency situations, to define the utility and market value and a method of multiple criteria design of a human resource management in emergency situations.
4. To develop an Intelligent Decision Support System for the Human Resource Management in Emergency Situations including Physiological Advisory Subsystem to Analyse a User's Post-Disaster Stress Management, Text Analytics Subsystem, Recommender Thermometer for Measuring the Preparedness for Resilience and integrating these subsystems with virtual reality.

Research methodology.

Comprehensive research on the object of the thesis required application of a multiple criteria analysis, recommender methods and physiological and intelligent technologies (text analytics, recommender and decision support) that enable users psychological, physiological, ethical, emotional, religious, ethnic, legislative, infrastructural and other aspects. The diversity of the factors being assessed should correspond to the various ways of presenting the data needed for decision making.

Defended Statements.

1. The original model for a complex analysis of a human resource management in emergency situations assesses more objectively a built environment's resilience management life cycle and its stages integrating the stakeholders involved in the project as well as its micro, meso and macro environments, making it an integral entity.
2. The Intelligent Decision Support System for the Human Resource Management in Emergency Situations integrates the multiple criteria analysis with recommender methods as well as with physiological and intelligent technologies (text analytics, recommender and decision support). It more objectively assesses a built environment's resilience management life cycle with its mitigation, preparedness, response and recovery stages, its involved parties and its micro, meso and macro level environmental factors. Next, it selects the most rational alternatives.

The scope of the scientific work.

The thesis is 162 pages long, not including its appendices and contains 37 numbered formulas for use, 20 illustrations and 17 tables. Preparation of this thesis was based on 213 references.

Approval of the thesis.

The main statements of the thesis were published in eleven scientific articles. The main statements of the thesis were discussed during five international and national scientific conferences. The data obtained in the research was used in the educational process, introducing it into the lecture courses on Web-Based and Biometric Decision Support in Business Management, Internet and Biometric Web Based Business Management Decision Support and Biometric and Intelligent Decision Support for Master's degree studies at Vilnius Gediminas Technical University.

The data obtained in the research was also used while participating in three international Erasmus – Lifelong Learning Programme projects: Academic Network for Disaster Resilience to Optimise Educational Development (ANDROID), Collaborative Action towards Disaster Resilience Education (CADRE) and Collaborative Reformation of Curricula on Resilience Management with Intelligent Systems in Open Source and Augmented Reality (RESINT).

Practical value.

The practical significance of the results is the complex analysis of a built environment's resilience management life cycle and its stages, which are used to create an Intelligent Decision Support System for the Human Resource Management in Emergency Situations to accelerate resilience in each of its stages, to manage personal stress and to reduce disaster-related losses.

The research findings can be applied in any organisation involved in emergency situations. The system presented in the dissertation can be used by the managers of the organisations, striving to improve work efficiency. This system can also be used by state organisations' representatives, which are striving to increase economic indicators and to reduce the negative impact of disasters. The proper preparation for disasters and the ability to recover quickly after them can help to improve management efficiency and reduce negative impact of disasters to society and economics.

Editor's comments

Dear EWG-ORSDCE members, dear friends,

Thank you for all valuable contributions to EWG-ORSDCE activities, common initiatives and research papers.

Next year all members of EWG-ORSDCE are welcome to participate in the EURO Conference 2016 that will be held in Poznan, Poland, July 3-6, 2016. You are also invited to participate in next meeting of EWG-ORSDCE (ORSDCE2016 Workshop on Flexibility in Sustainable Construction), which will be held on July 7-8, 2016 in Poznan, Poland.

On behalf of the Editorial Board of EWG-ORSDCE Newsletter
Tatjana Vilutienė

EWG-ORSDCE Newsletter Editorial Board: Tatjana Vilutienė, Edmundas Kazimieras Zavadskas