EDEN 2017 ANNUAL Conference

Diversity Matters!

EDEN 2017 Annual Conference

Jönköping, Sweden

13-16 June 2017

CONFERENCE PROCEEDINGS

Edited by

Airina Volungeviciene, András Szűcs
on behalf of the European Distance and E-Learning Network

European Distance and E-Learning Network, 2017

EDEN 2017 Annual Conference
Jönköping, Sweden

Published by the European Distance and E-Learning Network

Editors:

Airina Volungeviciene
András Szűcs

Editorial co-ordination:

Kriszta Mihalyi

EDEN Secretariat, c/o Budapest University of Technology and Economics
H-1111 Budapest, Egry J. u. 1, Hungary
Tel: (36) 1 463 1628, 463 2537
E-mail: secretariat@eden-online.org
http://www.eden-online.org

Conference Publication Sponsor

Supported by the Erasmus+ Programme of the European Union
The publication reflects the authors' view, the EACEA and the European Commission are not responsible for any use that may be made of the information it contains.

Copyright Notice 2017 European Distance and E-Learning Network and the Authors

This publication contributes to the Open Access movement by offering free access to its articles and permitting any users to read, download, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software. The copyright is shared by authors and EDEN to control over the integrity of their work and the right to be properly acknowledged and cited.

To view a copy of this licence, visit
http://www.creativecommons.org/licenses/by/4.0/

ISBN 978-615-5511-18-9

Introduction

The skills and knowledge required to take an active part in a society characterised by digital technology are embedded, learned, and practiced in people's daily lives. The ever-changing media- and technology landscapes create opportunities for learning at all stages in life in formal and informal settings. New policies and practices entailed by the high presence of digital tools have to take into account the "inclusion" or "exclusion" of different groups in society.

Technology and open education open doors to groups of learners from a range of backgrounds, generations, cultures with different languages, literacies, and ways of communication. It is difficult in the meantime to meet the evolving skills demand in the globalising value chains. Lifelong Learning is not yet a reality for most!

The behaviour, interests and roles of learners are also repositioned. Technological innovation implies faster learning, and instruction has to be "useful" in order to motivate and engage students. In order to strengthen and stabilise learning, the collaboration between the human mind and the machine have to be regularly reconsidered.

It is of great importance to study how the educational framing, from policy level down to the actual learning situation, allows for various types of e-learning, open and distance education. Diversity also causes fragmentation in learning achievements which should be carefully managed, without loosing identity of learners. One challenge is the often fragmented view of what has been achieved theoretically and practically in this field, and the ever-increasing offer of technology. Co-ordination of information, knowledge and creativity is of high importance for the educational experience.

How do educators deal with diversity in media and technology enhanced learning environments? How can such diversity be accounted for and used to transform and adapt online learning settings? **How do teachers and policy makers meet digital inequalities – what are the impacts of increasing complexity of stakeholder groups of education?** What will be the effects of socio-economic demands and large scale migration on learning?

Will the digital pedagogy arsenal be able to manage diversity in media and technology enhanced learning? How can learning analytics help in assessing and handling diversity in learners background and performance

How do we bring together the strengths of the past with the opportunities for the future?

The responsibility of the scholarly community includes the proper handling of diversity in education with respect to learners' profiles, backgrounds, generations, cultures with different languages, literacies, and ways of communication as well as diversity in media and technology enhanced learning environments. **We need renowned reflections of practice that support paradigm-changing transformations based on systematic knowledge.**

EDEN 2017 is the forum that offers a chance to work together for these goals, and to gain further insight into the core questions.

Ylva Lindberg
Dean of Research, Jönköping University

Airina Volungeviciene
EDEN President

Acknowledgement and thanks are given to the Programme and Evaluation Committee

Airina Volungeviciene, EDEN President, Vytautas Magnus University, Lithuania
Ylva Lindberg, Jönköping University, Sweden

Diana Andone, Politehnica University of Timisoara, Romania

Deborah Arnold, University of Burgundy, France

Sangeeta Bagga-Gupta, Jönköping University, Sweden

Ulrich Bernath, Ulrich Bernath Foundation for Research in ODL, Germany

Lisa Marie Blaschke, Carl von Ossietzky University of Oldenburg, Germany

Mark Brown, National Institute for Digital Learning, Dublin City University, Ireland

Giulia Messina Dahlberg, Jönköping University, Sweden

Helga Dorner, Central European University, Hungary

Christina Keller, Jönköping University, Sweden

Elsebeth Korsgaard Sorensen, Aalborg University, Denmark

Sandra Kucina Softic, University of Zagreb, Croatia

Fabio Nascimbeni, Universidad Internacional de la Rioja, Spain

Don Olcott Jr., Carl von Ossietzky University of Oldenburg, Germany

Ebba Ossiannilsson, Swedish Association of Distance Education, Sweden

André Petzold, Destination Jönköping, Sweden

Antonella Poce, University Roma III, Italy

Ulf Sandström, Swedish Association for Distance Education, Sweden

Sofoklis Sotiriou, Ellinogermaniki Agogi, Greece

Anette Svensson, Jönköping University, Sweden

Carl-Johan Svensson, Jönköping University, Sweden

Andras Szucs, Secretary General, EDEN, United Kingdom

António Moreira Teixeira, Universidade Aberta, Lisbon, Portugal

Wim Van Petegem, Katholieke Universiteit Leuven, Belgium

Lennart Wass, Jönköping University, Sweden

Steve Wheeler, Chair of EDEN NAP Steering Committee, University of Plymouth, United Kingdom

Madelene Zetterlind, Jönköping University, Sweden

TABLE OF CONTENTS

DIVERSITY AND ICT ENHANCED EDUCATION IN CONTEXT

LEARNING AT THE WORKPLACE

SOCIAL MEDIA AND ONLINE CO-OPERATION

INNOVATIVE E-LEARNING CONCEPTS

SOCIO-CULTURAL ASPECTS OF E-LEARNING

EMPOWERING THE DIGITAL TEACHER

WHAT'S NEW IN OPEN EDUCATION?

E-LEARNING POLICY AND STRATEGY ISSUES

MOOC PANORAMA

THE DIGITAL LEARNERS' NEEDS AND MOTIVATIONS

LEARNER NEEDS AND MOTIVATIONS

ICT ENHANCED LEARNING IN SCHOOLS

INTERNATIONAL E-LEARNING DEVELOPMENT CASES

POSTERS

Diversity Matters!
Proceedings of the European Distance and E-Learning Network 2017 Annual Conference
Jönköping, 13-16 June, 2017
ISBN 978-615-5511-18-9

EFFECTIVE STRATEGIC DECISION MAKING ON OPEN AND DISTANCE EDUCATION ISSUES

Nikola Kadoić, Blaženka Divjak, Nina Begičević Ređep,
University of Zagreb, Faculty of Organization and Informatics, Croatia

Abstract

Strategic decision making about education and open and distance education (ODE) issues requires analytic approach supported by a suitable method. The Analytic Network Process (ANP) meets all the requirements of decision making in higher education (HE), but it is very rarely used in practice because of its weaknesses. The weaknesses are related to the complexity of the method and demand on resources in the process of implementation. An upgraded ANP method that combines the ANP with the Social Network Analysis (SNA), which diminishes some of the weaknesses of the original ANP, is presented in this paper.

Introduction

Current ODE and e-learning challenges are related to diversity of student body, open learning environments, learning analytics, labour market needs, specific characteristics and demands that come from users, changing users' attitudes, behaviours and roles (The NMC Horizon Report, 2017). Bates predicts (Bates, 2014) disappearance of online learning as a separate construct, then that multi-mode delivery will be concentrated in fewer institutions but with more diversity and with multiple levels of service and fees, that it is coming an end of the lecture-based course and written exam, establishing the final implementation of lifelong learning with new financial models, that systematic faculty development and training is crucial, that all that provoke devolved decision-making and organizational models, more difficult issues with student privacy, data security and student online behaviour. Dealing with those challenges requires strategic decision making. Using appropriate methodology for strategic decision making (DM) is crucial to make effective decisions.

The research presented in this paper has been prepared in the scope of the project "Development of a methodological framework for strategic decision making in higher education – a case of open and distant learning implementation" (HigherDecision) supported by Croatian Science Foundation (web: higherdecision.foi.hr). The primary goal of HigherDecison project is to develop a complete methodology for strategic decision making and monitoring of its implementation in HE. Two basic components of the project are: (a) Development of methodological framework for strategic DM and monitoring of its implementation; (b) Application, adjustment and evaluation of methodology on the example of decision implementation on ODL and e-learning.

In our previous research, we investigated decision making methods and methodologies used in the decision making in HE and/or ODL. We defined characteristics of decision making in HE and analysed DM methods in order to be applicable for decision making in HE and particularly suitable for the area of ODL and e-learning.

The specific objectives of this paper are:

- to discuss the most suitable methods for strategic decision making in HE, and
- to present upgraded ANP method for strategic decision making illustrated with an example of using the upgraded ANP method on an e-learning problem.

Previous research

In the scope of the project HigherDecision we have investigated which decision making methods and methodologies are used in the decision making processes in higher education connected to ODL (Kadoić, Begičević Ređep, & Divjak, 2016). Results show diversity of methods, methodologies and approaches used in the strategic decision making on ODL that proves complexity of the topic and variety of approaches. The most frequently used method was the Analytic Hierarchical Process (AHP) which is the most well-known multicriteria decision making method.

In the second phase of our research we defined characteristics of decision making in HE (Divjak, 2016) and created a list of characteristics of DM methods in order to be applicable in the area of HE and ODL (Divjak & Begicevic, 2015). In Table 1 we list several decision making methods and assess how they fit HE and e-learning/ODL demands (Divjak & Begicevic, 2015; Wudhikarn, 2016).

Table 1: How different decision making methods fit HE and e-learning/ODL demands

HE and e-learning/ODL demands	ANP	AHP	Promethee	Electre	Topsis
Problem structuring	+	+	-	-	-
Multi-criteria method	+	+	+	+	+
Modelling influences between Decision making elements	+	-	-	-	-
Qualitative scale (criteria)	+	+	+	+	+
Quantitative scale (criteria)	+	+	+/-	+/-	+/-
Group decision making	+	+	+/-	+/-	+/-
Sensitivity analysis	+	+	+	+	+
Risks and opportunities	+	+	+	+	+
Benefits and costs	+	+	+	+	+

Based on the obtained results shown in Table 1, our conclusion is that the most suitable decision making method for strategic decision making in HE and e-learning/ODL issues is the Analytic Network Process (ANP). The ANP is a Multi Criteria Decision Making (MCDM) method introduced by Saaty (2001) as a generalization of the AHP method. The AHP method is one of the most widely exploited MCDM decision-making methods in cases when the decision (the selection of given alternatives and their prioritizing) is based on several tangible and intangible criteria (sub-criteria). However, many decision problems, especially in HE and

ISBN 978-615-5511-18-9

ODL, cannot be structured hierarchically because they involve the interaction and dependence of higher-level elements in a hierarchy on lower-level elements. Therefore, creation of a network of elements is needed (Begičević, Divjak, & Hunjak, 2009). The basic structure of the ANP is an influence network of clusters and nodes contained within the clusters (Saaty & Cillo, 2008). This characteristic differentiates the ANP from the AHP. Priorities in the ANP network are obtained in the same way as in the AHP by using pairwise comparisons and judgments. The first step in an ANP application is to group the criteria that influence decision in clusters. The next step is to do pairwise comparisons using judgments based on the Fundamental Scale (1 to 9 scale of absolute numbers) (Saaty, 2001) and deriving priorities as the eigenvector of the judgment matrices. The main steps of the ANP are briefly described in the following section, but a detailed outline can be found in (Saaty & Vargas, 2006). Furthermore, in sections 4 and 5 we have listed the main ANP disadvantages and proposed the ANP upgrade that eliminates some of the identified disadvantages. In section 5 we have discussed and illustrated with an example why upgrade of the ANP is more usable for decision makers in HE and e-learning/ODL that original ANP.

The Analytic Network Process (ANP)

The basic elements of the ANP are clusters and nodes (criteria) contained within the clusters. A network has clusters of elements, with the elements in one cluster being connected to elements in another cluster (outer dependence) or the same cluster (inner dependence). In outer influence one compares the influence of elements in a cluster on elements in another cluster with respect to a control criterion and in inner influence one compares the influence of elements in a group on each one (Begičević et al., 2009). The main steps of the ANP illustrated with the example of a problem structured in two clusters are (Saaty & Cillo, 2008) as follows.

1. Decision making problem structuring

Decision making problem structuring – identification of alternatives and criteria and grouping criteria into clusters (in Figure 1. there are two clusters k1-k2 and k3-k4-k5); the influences between criteria (nodes) are defined (dotted arrows); alternatives from cluster a1-a2-a3 are connected with all criteria (solid arrows).

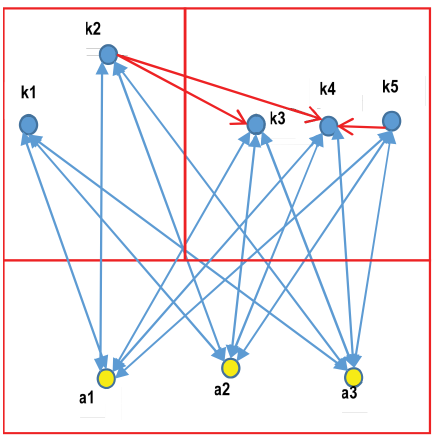

Figure 1. Structure of decision making problem (clusters and alternatives)

ISBN 978-615-5511-18-9

2. Construction of the supermatrix

Construction of the supermatrix – two-dimensioned matrix that indicates criteria and alternatives rows and columns (Table 2). In cells are weights of criteria and priorities of alternative (calculated in Step 3). Problem shown in Figure 1 has one supermatrix because the problem is simplified – two criteria clusters are parts of one control criteria.

Table 2: Unweighted supermatrix

	C	k1	k2	k3	k4	k5	a1	a2	a3
C	0	0	0	0	0	0	0	0	0
k1	0,4	0	0	0	0	0	0,4	0,3	0,8
k2	0,6	0	0	0	0	0	0,6	0,7	0,2
k3	0,3	0	0,4	0	0	0	0,5	0,1	0,4
k4	0,3	0	0,6	0	0	1	0,15	0,3	0,3
k5	0,4	0	0	0	0	0	0,35	0,6	0,2
a1	0	0,2	0,5	0,3	0,4	0,3	0	0	0
a2	0	0,7	0,1	0,1	0,2	0,4	0	0	0
a3	0	0,1	0,4	0,6	0,4	0,3	0	0	0

3. Pairwise comparisons

The data to fill supermatrix is calculated by pairs-wise comparisons of cluster elements. Criteria and alternatives are compared by using Saaty's scale of relative importance. The scale has 9 values (degrees): 1 means that two elements are equally important, 3 means moderate importance of one element over other, 5 means strong importance, 7 means demonstrated importance and 9 means absolute importance (intermediate values 2, 4, 6 and 8 as well as real numbers between 1 and 9 are used) (Saaty, 2008). When making comparisons, we have to pay attention on inconsistency ratio (number that describes if transitivity relation has been satisfied).

Comparisons needed in our example (Figure 1):

1. Comparisons of elements in each criteria cluster: k1-k2 and k3-k4-k5. Criteria weights are visible in Table 2, column C, rows k1-k5;
2. Comparisons of criteria that are influenced by same criteria k3 and k4 are compared to k2 (results are shown in column k2, rows k3-k4). k5 influences (only) k4 which means that in column k5, row k4 1 is written;
3. Comparisons of criteria values per each alternative; in each cluster. 6 pairwise comparisons should be made: comparing criteria k1-k2 in pairs with respect to a1, a2 and a3; then comparing criteria k3-k4-k5 with respect to a1, a2 and a3. Results are shown in Table 2 in columns a1-a3, rows k1-k5;
4. Comparisons of alternatives with respect to each criterion. Results are shown in columns k1-k5, rows a1-a3.

ISBN 978-615-5511-18-9

4. Comparisons on cluster levels

The goal of this step is to get weighted supermatrix (Table 3) which consists of eigenvectors (sum of all values in each column equals 1). In our example we have to do:

1. Comparison of clusters k1-k2 and k3-k4-k5 with respect to goal in order to get cluster weights which will normalize column C;
2. Comparison of clusters k1-k2 and k3-k4-k5 with respect to alternative cluster (a1-a2-a3) in order to get cluster weights which will be used to normalize columns a1, a2 and a3;
3. Comparison of cluster k3-k4-k5 with cluster a1-a2-a3 with respect to k3-k4-k5 in order to get weight which will be used to normalize column k5;
4. Comparison of cluster k3-k4-k5 with cluster a1-a2-a3 with respect to k1-k2 in order to get weights which will be used to normalize column k2.

Table 3: Weighted supermatrix

	C	k1	k2	k3	k4	k5	a1	a2	a3
C	0	0	0	0	0	0	0	0	0
k1	0,2	0	0	0	0	0	0,2	0,15	0,4
k2	0,3	0	0	0	0	0	0,3	0,35	0,1
k3	0,15	0	0,2	0	0	0	0,25	0,05	0,2
k4	0,15	0	0,3	0	0	0,5	0,075	0,15	0,15
k5	0,15	0	0	0	0	0	0,175	0,3	0,1
a1	0	0,2	0,25	0,3	0,4	0,15	0	0	0
a2	0	0,7	0,05	0,1	0,2	0,2	0	0	0
a3	0	0,1	0,25	0,6	0,4	0,15	0	0	0

5. Calculating limit-matrix

When we multiply matrix from Table 2 with itself and repeat that procedure, after final number of steps we get matrix that by multiplying does not change anymore. That is a limit-matrix. There are two possible situations: limit matrix with circular influences between elements and limit matrix without circular influences between elements. In the first case, a multiplying must be used to get matrix in which all values in the same row are equal (those are final criteria weights and alternative priorities). In the second case, the Cesaro formula for calculating criteria weights and alternative priorities must be used.

6. Sensitivity analysis

Analysis that shows how a change in input parameters influences the output parameters (Saaty, 2001). In terms of the ANP, input parameters are comparison values in steps 3 and 4. Output parameters are criteria weights and alternative priorities. In this step, we slightly (for 5 %) change input values and observe what happens with output variables. We are especially interested in observing alternative with highest priority – whether it is going to stay with highest priority after the changes of all input variables occur (±5%).

ISBN 978-615-5511-18-9

Disadvantages of the ANP

Despite many advantages, some disadvantages cause low rate of the ANP practical implementations. Here are some recognized disadvantages for using the ANP:

1. Saaty's scale is not big enough (Saaty & Vargas, 2006);
2. The ANP is mainly used in nearly crisp decision applications (Ayağ & Samanlioglu, 2016);
3. Large number of comparisons – solution to that problem is introducing ratings of alternatives instead of pairwise comparisons (Saaty, 2008), but then we get less precise results (Saaty & Vargas, 2006);
4. Questionable understanding of comparisons of two criteria with respect to the third one (our example: in 3a. step we have to compare k3 and k4 with respect to goal, but in 3b. step we also have to compare k3 and k4, but this time with respect to k2 – that is often confusing);
5. Comparisons of clusters are also often very confusing and not understandable (our example: in 4a. step we have to compare two clusters with respect to goal, and in 4b. we also have to compare the same cluster, but now with respect to cluster a1-a2-a3). People often do not differentiate between those two comparisons and do not know how to include influences between clusters when forming judgement;
6. High complexity of the method in general and in comparing with the AHP. The AHP covers only some of the ANP steps. In the AHP, we do not care about influences between criteria, which makes the first step much simpler. In our example, if we want to use the AHP instead of the ANP, there is no need to conduct 3b and 3c steps, as well as 4a, 4b and 4c. That also makes the AHP much simpler. Additionally, it makes the AHP a more often used method than the ANP.

The ANP upgrade

The ANP upgrade has focus on using the advantages of the SNA (Social Network Analysis) to diminish disadvantages of the ANP. Both methods are based on graph theory that enables their combination.

Basic elements of the SNA in light of the graph theory are nodes/vertices (elements) and ties/edges/loops (connections, ordered or unordered pairs of nodes). Graphically, nodes are presented as points and ties as lines or arrows depending on the type of a tie (directed or undirected tie). Furthermore, ties can be unweighted (binary) or weighted. Binary tie has just the information if two nodes are connected, whereas weighted tie has additional information on intensity of connection between two nodes. In terms of the SNA, there are two basic types of analysis: centrality measures and substructures in network. We will focus on centrality measures because they can be helpful when calculating criteria weights. Centrality measures are related to nodes and they show importance of a certain node. There are three basic measures (Knoke & Yang, 2008):

ISBN 978-615-5511-18-9

1. *Centrality degree* is the simplest centrality measure. It equals to the number of ties that are connected to a particular node. In directed graphs, we differ between centrality indegree (the number of ties that "come in" certain node) and centrality outdegree (the number of ties that "come out" from certain node).
2. *Closeness centrality* is a centrality measure that calculates how close a certain node is to all other nodes. Calculation of this measure is based on geodesic distances (a shortest path between the nodes) between observed node and all other nodes. Characteristics of node with high closeness centrality are: fast access to all other nodes and high influence on other nodes.
3. *Betweenness centrality* is a centrality measure that represents the degree of which nodes stand between each other. In other words, the betweenness centrality counts how many shortest paths between each pair of nodes of the graph pass by a node.

The ANP upgrades presented in this paper are based only on the three main centrality measures and it was developed by using *design science research process* paradigm (Hevner & Chatterjee, 2010). In accordance with this approach, we have defined several types of ties for the purpose of upgrading the ANP. They are described as follows and illustrated here by the example explained in the Demonstration.

- *Domination ties* are ties between nodes that come as a result of comparing criteria, alternatives and clusters by using Saaty's scale. Influences between criteria are not considered (analogy with the AHP). Figure 2 describes the example from the section 3. There are five criteria clusters and, as it was presented in section 3, step 3a, we have to do pairwise comparisons of all criteria. In terms of the SNA we got weighted directed graph.
- *Influences between criteria as ties in network* – In the first step of the ANP we make decision making problem structure. We list all criteria as well as influences between them. Also, we have to measure those influences. The example is presented in Figure 3. Red lines represent influences between criteria (influences do not have to exist between all criteria). The difference between our upgrade and original ANP is visible in this step: in the original ANP we would have to do pairwise comparisons of all elements that are influenced by the same node and in our method experts do not make comparison because only data about influences between criteria in weight calculation are included.
- *Influences between criteria resulted from alternatives as ties in network* – Now we analyse each alternative and compare criteria with respect to values of alternatives. In our example, a certain alternative has excellent value on criteria 2, but very low value on criteria 1 – that means that we draw tie between node 2 and 1. In Figure 4 additional ties are shown (when compared to Figure 3) – those are ties which came as a result of comparing criteria values per each alternative. This step contains no significant difference related to the original ANP method.

ISBN 978-615-5511-18-9

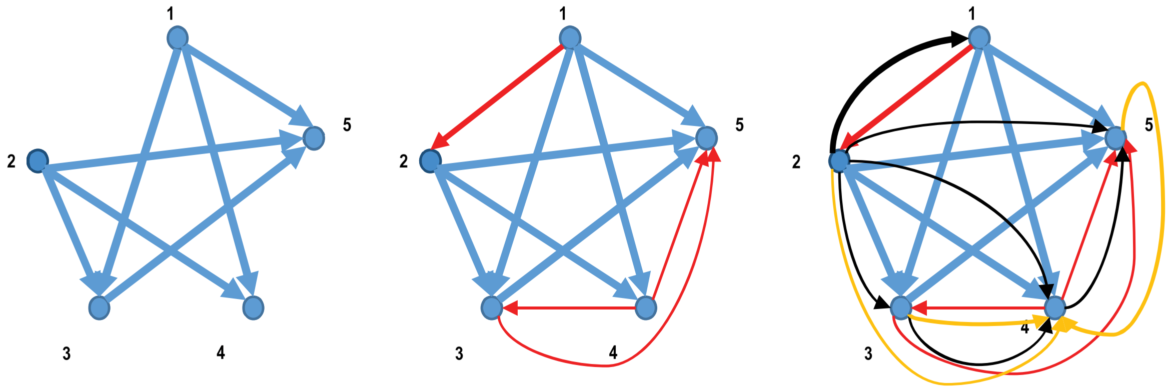

Figure 2., Figure 3. and Figure 4. Types of ties in upgraded ANP

- *Alternative domination ties* – We will get final weights of criteria from Figure 5 by calculating and normalizing centrality measures for each criteria. Then we make alternative network and draw ties between nodes with respect to real values of alternatives per each criteria. After that it is possible to calculate global priorities and decide. In Figure 5 there are two alternatives and dominations between them per each criterion.

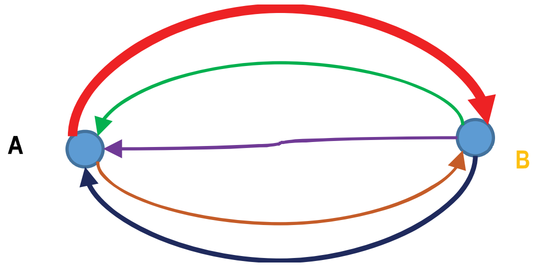

Figure 5. Alternative domination ties

In situation with more clusters (step 4 from section 3), in the original ANP method, we would have to compare clusters in pairs with respect to goal (in example step 4a). The clusters would also have to be compared with respect to other clusters depending on existence of ties between cluster criteria. In the upgraded ANP, we would have to compare clusters only with respect to goals. Ties between clusters will be incorporated to clusters' weights with centrality measures.

Demonstration

In order to demonstrate the method, we selected a problem of comparing popularity of Edmodo and Moodle (data taken from: http://www.capterra.com/learning-management-system-software, 2016). Table 4 contains data about decision making problem: criteria (Number of customers, Number of users, Facebook likes and inFollowers), alternatives (Moodle and Edmondo) and values. The results must show which one is a better choice based on defined criteria and judgements of decision makers.

The criteria weights and priorities of alternatives are shown in Table 5. Weights of criteria in ANP upgrade method are calculated normalizing centrality values. The results show different priorities of alternatives (Moodle and Edmondo) if we are using different methods for

ISBN 978-615-5511-18-9

decision making. Figures 2-5 represents nodes and ties for this example. As it is shown in Table 5, the final results are very similar for three methods. However, upgraded ANP method used less resources for obtaining the result than original ANP without losing network structure of the decision making problem modelling.

Table 4: Comparing popularity of Edmodo and Moodle

	1 Costumers	2 Users	3 Facebook likes	4 inFollowers	5 Twitter followers
A Moodle	70569	89237532	20747	8808	24400
B Edmodo	350000	58000000	69485	4753	111000

Table 5: Comparing different decision making methods results

	1 Costumers	2 Users	3 Facebook	4 LinkedIn	5 Twitter	A Moodle	B Edmodo
AHP	0.365	0.365	0.09	0.09	0.09	0.44	0.56
Original ANP	0.378	0.385	0.094	0.083	0.06	0.46	0.54
ANP upgraded	0.346	0.367	0.0911	0.0971	0.0988	0.47	0.53

Conclusion

In this paper, we presented basics of the upgraded ANP method that eliminates some of disadvantages of the original ANP, such as complexity of the method and a large number of pair-wise comparisons that decision maker must do. We have combined the methodology of decision making modelling applied in the ANP with centrality measures used in the SNA in order to develop an upgraded ANP that has direct impact on decreasing disadvantages 3-6 from the list of disadvantages mentioned in section 4. With a new method, the number of criteria comparisons on cluster level is decreased and all comparisons that are result of criteria or cluster influences in original ANP are now excluded because influences are incorporated in model through centrality measures. That can be done by using only data provided in step 1 of the ANP. This also eliminates disadvantages 4 and 5 because decision makers do not have to do comparisons that usually are not understandable to them. Complexity of algorithm for finding solution of a decision making problem is also lowered. It is still higher than the complexity of the AHP but the upgraded ANP, similarly as original ANP, is modelling influences between criteria. In the next phases of our research we are planning to do a validation of the developed method by using a number of simulations on different decision making problem structures.

References

1. Ayağ, Z., & Samanlioglu, F. (2016). An intelligent approach to supplier evaluation in automotive sector. *Journal of Intelligent Manufacturing, 27*(4), 889–903. http://doi.org/10.1007/s10845-014-0922-7

2. Bates, T. (2014, January 12). 2020 Vision: Outlook for online learning in 2014 and way beyond. Tony Bates [Blog Post]. Retrieved January 30, 2017, from http://www.tonybates.ca/2014/01/12/2020-vision-outlook-for-online-learning-in-2014-and-way-beyond/

ISBN 978-615-5511-18-9

3. Begičević, N., Divjak, B., & Hunjak, T. (2009). Decision-making on prioritization of projects in higher education institutions using the analytic network process approach. *Central European Journal of Operations Research, 18*(3), 341–364. http://doi.org/10.1007/s10100-009-0113-3
4. Divjak, B. (2016). Challenges of Strategic Decision-Making within Higher Education and Evaluation of the Strategic Decisions. In T. Hunjak, V. Kirinić, & M. Konecki (Eds.), *Central European Conference on Information and Intelligent Systems* (pp. 41–46). University of Zagreb, Faculty of Organization and Informatics Varaždin.
5. Divjak, B., & Begicevic, N. (2015). Strategic Decision Making Cycle in Higher Education: Case Study of E-learning. *Proceedings of the International Conference on E-learning 2015.* Retrieved from http://www.researchgate.net/publication/280711901
6. Hevner, A., & Chatterjee, S. (2010). *Design Science Research in Information Systems*, 9–22. http://doi.org/10.1007/978-1-4419-5653-8_2
7. Kadoić, N., Begičević Ređep, N., & Divjak, B. (2016). E-learning decision making: methods and methodologies. *Proceedings of the EDEN Annual Conference 2016, Re-Imagining Learning Scenarios*, 24. Budapest, Hungary: European Distance and E-Learning Network.
8. Knoke, D., & Yang, S. (2008). *Social Network Analysis* (Quantitative Applications in the Social Sciences).
9. Saaty, T. L. (2001). Decision Making with Dependence and Feedback: The Analytic Network Process: The Organization and Prioritization of Complexity (2nd ed.). New York: RWS Publications.
10. Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International Journal of Services Sciences, 1*(1), 83–98.
11. Saaty, T. L., & Cillo, B. (2008). *A Dictionary of Complex Decision Using the Analytic Network Process, The Encyclicon* (Volume 2, 2nd ed.). Pittsburgh: RWS Publications.
12. Saaty, T. L., & Vargas, L. G. (2006). Decision Making with the Analytic Network Process: Economic, Political, Social and Technological Applications with Benefits, Opportunities, Costs and Risks. Softcover reprint of hardcover 1st ed. 2006 edition (December 28, 2009). Springer.
13. The NMC Horizon Report (2017). *NMC Horizon Report Preview 2017 Higher Education Edition*. EU. Retrieved from http://cdn.nmc.org/media/2017-nmc-horizon-report-he-preview.pdf
14. Wudhikarn, R. (2016). An efficient resource allocation in strategic management using a novel hybrid method. *Management Decision, 54*(7), 1702–1731. http://doi.org/10.1108/MD-08-2015-0380

ISBN 978-615-5511-18-9

Acknowledgment

This work has been supported by Croatian Science Foundation under the project Higher Decision IP-2014-09-7854.

ISBN 978-615-5511-18-9