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MODELLING THE STRUCTURES OF STAKEHOLDER PREFERENCES

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Abstract

A modern view on the evaluation of the project's success turns into managing stakeholders expectations. Those expectations are based on identification of stakeholders needs. Different groups of stakeholders can have different power and consequently different influence on project. Determining they influence, we can establish needs priorities for all the project. As we claim, they are consequence of stakeholder's preferences. Determination of structure of stakeholder preferences can be helpful in managing the project, and thus in achieving its success. The aim of the research is to develop a procedure for determining the structure of the preferences different groups of stakeholders. The problem was solved using an Analytic Hierarchy Process (AHP) and its extension Analytic Network Process (ANP).

Key words: *Stakeholders management, Mathematical Methods, Preference Modelling, AHP and ANP methods*
JEL code: C65

Introduction

Project evaluation by stakeholders, is one of the key elements of the project's success. The establishing new knowledge areas in the ISO 21500 standard (ISO 21500: 2012) and also in fifth edition of PMBoK (Project Management Institute, 2013), dedicated only to the stakeholders, is the realization of this view. In technical projects, it is important to define stakeholder expectations for the product being developed. They take the form of requirements. One of processes defined in PMBoK Scope Management knowledge area is collecting requirements.

In practical projects we may obtain few thousand requirements, they prioritization play important role. This problem first arises in software engineering. Recent literature survey (Achimugu et al., 2014) reports 73 studies, first of them dated late 1990. Among the many methods used, the most commonly cited is method AHP (Analytic Hierarchy Process). The same problem of requirements prioritization arise in projects ruled with system engineering principles, as described in SEBoK (BKCASE Editorial Board, 2017).

The question arises: can we use in requirements prioritization, the knowledge about the influence of stakeholders on the project. To do that first we must describe they dependencies and influence on project.

This paper proposes to use Analytic Network Process to describe stakeholders' structure of preferences. This structure may be later used to requirements prioritizations.

Research results and discussion

2. Analytic Network Process

Analytic Network Process (ANP) (Saaty, 1996), is a extension of Analytic Hierarchy Process (AHP). In this method both criteria and variants are called elements. They are grouped into components (clusters). As seen in figure 1 we define source components, sink components and intermediate components. They are connected with paths of influence. We can consider two

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types of dependence: inner dependence between elements of this same component and outer dependence between elements of different components.

We can define paths of dependencies using tabular method as presented in table 1.

Table 1

Tabular method

Influencing components	**List of components**	**Influenced components**
C_2	C_1	
C_2, C_1	C_2	C_2, C_j,
...	...	...
C_2, C_j	C_N	C_1

Source: author's calculations based on (Saaty, 1996)

The impact of a given component on another component is derived from paired comparisons as in AHP method.

The derived weights ($\square_{ij}$) are used to weight the elements of the corresponding column blocks of structure called initial supermatrix (W). It is assigned zero when there is no influence. Initial supermatrix is obtained by paired comparisons on the elements within the clusters. This supermatrix is a two-dimensional matrix. The priority vectors from the paired comparisons appear in the appropriate column of this structure. We obtain weighted supermatrix ($\overline{W}$) using equation (1) :

$$\overline{W} = \left[W_{ij} * v_{ij}\right] \quad (1)$$

Then we compute limited supermatrix (G) raising the weighted supermatrix to k power, using equation (2):

$$\lim_{n\to\infty} \overline{W}^{k} = G \quad (2)$$

Columns of limited supermatrix give as priorities of components and elements.

In order to prioritize requirements, we will define the structure of the relationship between stakeholders. An example structure is shown in Figure 2. The structure was obtained by a tabular method as shown in Table 2.

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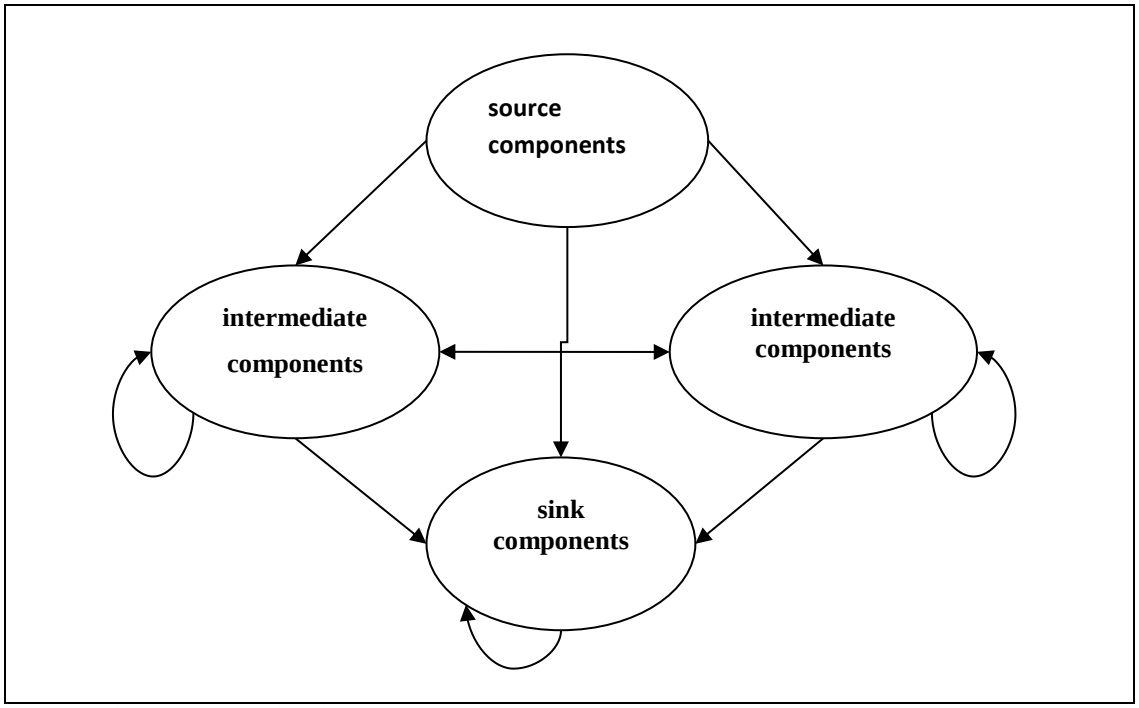

Source: author's construction based on (Saaty, 2005)

Fig. 1. **ANP model structure**

3. Proposed method

In order to prioritize requirements, we will define the structure of the relationship between stakeholders. An example structure is shown in Figure 2. The structure was obtained by a tabular method as shown in Table 2.

Table 2

Tabular method

Influencing stakeholder	List of stakeholders	Influenced stakeholder
	Aim	*S,C,PM, CFO, SE, Team*
C	*S*	*PM, CFO, C*
S	*C*	*S,SE*
S,C,CFO	*PM*	*S, CFO, Team, SE*
S, PM	*CFO*	*PM, Team*
C, PM	*SE*	*C, PM*
PM,CFO	*Team*	

Source: author's calculations based on (Saaty, 1996)

We have in clusters with stakeholder sponsor (*S*), client (*C*). There is also chief Finance Officer (*CFO*). We have team members (*Team*) and project manager (*PM*). There is also system engineer (*SE*). Figure 2 also shows cluster with requirements not considered in this work. In practical issues, cardinality of clusters may be bigger.

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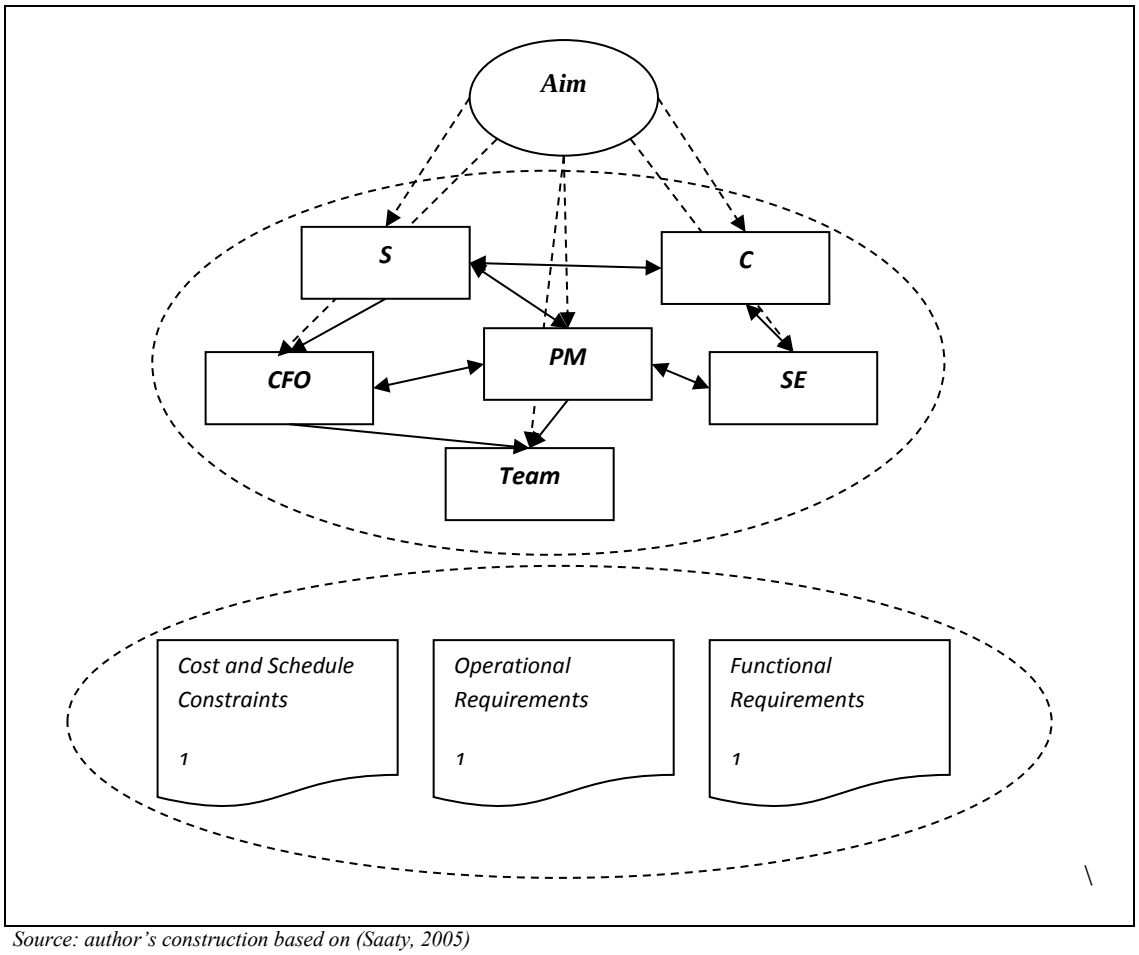

Source: author's construction based on (Saaty, 2005)

Fig. 2. **ANP model structure**

The proposed procedure consists of the following steps:

1. Identification of stakeholders
2. Grouping stakeholders in the cluster
3. Identification the relationships between stakeholders
4. Definition of dependency network
5. Perform paired comparisons of clusters.
6. Perform paired comparisons on the stakeholders within the cluster.
7. Collecting requirements
8. Grouping requirements in clusters
9. Constructing initial supermatrix and weighted supermatrix
10. Calculating limited supermatrix

Grouping requirements in clusters can be done by type of requirements or by requirement's owner.

Table 3 shows an exemplary relationship between stakeholders, as measured by Saaty's scale. Super Decision software was used in calculations. Level of Inconsistency is 0.031.

Table 3

Comparisons with respect to "*Aim*" element in "Stakeholders" cluster

Elements	*S*	*C*	*PM*	*CFO*	*SE*	*Team*
S	1	1/3	3	3	3	5
C	3	1	5	5	5	7
PM	1/3	1/5	1	1	1	3
CFO	1/3	1/5	1	1	1	3
SE	1/3	1/5	1	1	1	5
Team	1/5	1/7	1/3	1/3	1/5	1

Source: author's own calculations in Super Decision

Comparisons with respect to Client (*C*) element in "Stakeholders" cluster is presented in Table 4 (Inconsistency is 0.037).

Table 4

Comparisons with respect to Client element in "Stakeholders" cluster

Elements	*S*	*SE*	*Team*
S	1	3	5
SE	1/3	1	3
Team	1/5	1/3	1

Source: author's own calculations in Super Decision

Comparisons with respect to Chief Financial Officer (*CFO*) element in "Stakeholders" cluster is presented in Table 5 (Inconsistency 0.000)

Table 5

Comparisons with respect to *CFO* element in "Stakeholders" cluster

Elements	*S*	*SE*
PM	1	5
Team	1/5	1

Source: author's own calculations in Super Decision

Comparisons with respect to Project Manager (*PM*) element in "Stakeholders" cluster is presented in Table 6 (Inconsistency 0.058).

Table 6

Comparisons with respect to *PM* element in "Stakeholders" cluster

Elements	*S*	*CFO*	*SE*	*Team*
S	*1*	*3*	*5*	*5*
CFO	1/3	1	1	5
SE	1/3	1	1	5
Team	1/5	1/5	1/5	1

Source: author's own calculations in Super Decision

Comparisons with respect to Sponsor (*S*) element in "Stakeholders" cluster is presented in Table 7 (Inconsistency is 0.000)

Table 7

Comparisons with respect to *S* element in "Stakeholders" cluster

Elements	*C*	*PM*	*CFO*
C	1	3	3
PM	1/3	1	1
CFO	1/3	1	1

Source: author's own calculations in Super Decision

Comparisons with respect to System Engineer (*SE*) element in "Stakeholders" cluster is presented in Table 8 (Inconsistency 0.000).

Table 8

Comparisons with respect to *SE* element in "Stakeholders" cluster

Elements	*C*	*PM*
C	1	5
PM	1/5	1

Source: author's own calculations in Super Decision

The matrices shown in Tables 3-8 were used to construct the initial supermatrix. Weight for this only one cluster was 1, so weighted supermatrix was the same. Then, using method presented in equation (2), limited supermatrix was computed in Super Decision software. Columns of this supermatrix are the same. They represent priorities of stakeholders. They are presented in Table 9.

Table 9

Priorities

Stakeholders	**Priorities**
S	0.2799
C	0.2808
PM	0.1667

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CFO	0.0979
SE	0.1155
Team	0.0591

Source: author's own calculations in Super Decision

We can see that most influential is Client, then Sponsor. Less influential are Project Manager and System Engineer. According to relation between stakeholders at the end we have CFO and project team members.

Conclusions

In presented paper ANP method was used to finding influence stakeholders on project. There was considered also relations between them. The resulting impact priorities will be used in further work to prioritize requirements.

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