# DEFINING THE DECISION MAKING PROCESS OF CHOOSING THE RIGHT SOFTWARE SOLUTION FOR VIRTUAL TEAMS

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**Abstract**: Economic conditions have forced more companies to undertake projects with foreign teams (virtual teams), composed of temporary employees from different parts of the world, relying heavily on virtual communication. Because of the large variety of information and communication tools available to support virtual collaboration, the decision making process of choosing the right software solution has to consider the particular needs and requirements related to the specificity of the collaborative work. Ranking and selecting the right software tool is a relatively common, but still a difficult task. Software tool selection is vital for the virtual team's success and it is a multi-criteria decision-making problem of strategic importance for most virtual teams. In addition, to the conventional methods for software tools selection (based on efficiency analysis), the ELECTRE method represents a tool for optimizing decisions under certainty conditions. This is the proposed approach in the present paper. The main features of using ELECTRE method (in the above mention decision process) are simplicity, clearness and stability. The aim of this paper is to describe a possible mathematical model for the decision making process in choosing the right software solution for virtual team using ELECTRE method. The following software solutions are considered and analyzed for supporting virtual teams' collaborative work: Anymeeting, Arel Spotlight, Enovia 3D Live, Caltech's EVO, Live Meeting, Lotus Sametime, Skype and WebEx. Based on their functionalities description that are considered in the ELECTRE method as decision criteria, the conclusion will suggest the software optimal solution that is recommended to be adopted with minimum costs, too.

## 1. INTRODUCTION

Today, modern organizations build-up and encourage the development of virtual teams/networks for better attend their global objectives/interests in the global economy. The changes in managing people, employees have underlined, in the last years, the importance of virtual teams (created by the organization extension boundaries) for the global business management. A virtual team is known as a geographically dispersed team and it consists of a group of individuals that work across time, space and organizational boundaries with links strengthened by information and communication technology (ICT). The work nature and business processes have begun to shift from a production-based to service related business spawning a new generation of knowledge worker no longer bound to a physical work location. These phenomena suggest that firms are faced with increasing challenges to coordinate tasks across time zones, physical boundaries, cultures, and organizational contexts. The increasing globalization of trade and corporate activity increases the pressure to innovate and provide quality services to worldwide markets. Over time, this has led organizations to choose the most qualified people, a "dream-team," regardless of their physical location (Kerber, 2004). These remotely connected dream teams are known as global virtual teams (Draghici et. al., 2007).

Methods and tools based Internet technologies (e. g. web based technologies, web-based information system) have been developed in the last years to support not only communication, but also work processes where distributed functionalities related to virtual teams are needed. Virtual teams are organizational entities developed to facilitate distributed business processes of our days. Their communication and work are strongly support by web-based *applications that allow data, information, and knowledge creation, transfer, sharing and exploitation.*

*If the team is 100% virtual, organization must empower team with the best tools, it must ensure that the conference calls are aided with web tools and board sharing and* it must establish consistent communication protocols and behavior (Kohrell, 2011). The actual virtual teams are using complex software tools to collaborate and to attend complex tasks (software tools that are capable of project management and real-time communication between members). Different types of collaborative software tools can be grouped in the following categories: (1) free collaborative software; (2) groupware, (3) collaborative real-time editors and (4) wiki software (Figure 1). But without a brief description and test of each software solution, it is difficult to select the right tool to support a virtual team.

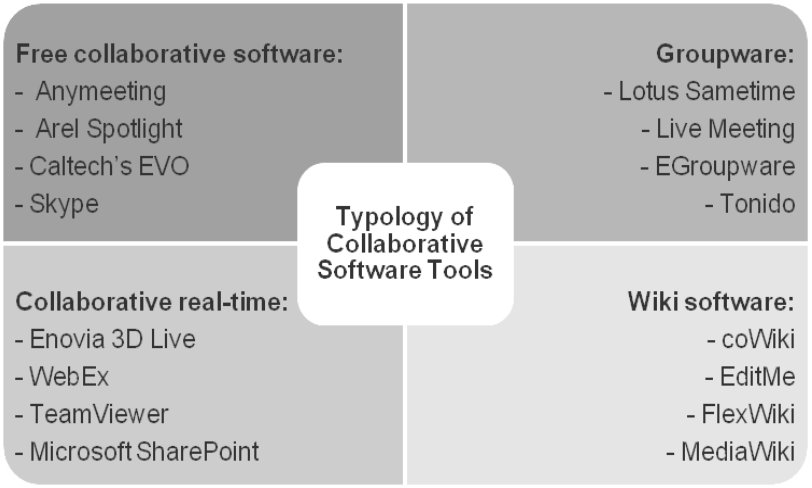


***Figure 1. Typology of Collaborative Software Tools.***

The aim of this article is to show the mathematical model for the decision making process for choosing the right software solution for virtual team using ELECTRE (Elimination et Choix Traduisant la Réalité) method. The following software solutions that can be used to define the collaborative environment will be considered: Anymeeting, Arel Spotlight, Enovia 3D Live, Caltech's EVO, Live Meeting, Lotus Sametime, Skype and WebEx.

## 1. METHODOLOGY FOR DECISION SUPPORT

Multi-criteria decision-making (MCDM) is one of the most widely used decision methodologies in the sciences, business, government and engineering worlds. MCDM methods can help to improve the quality of decisions by making the decision-making process more explicit, rational, and efficient. Decision making is a continuous process of correlation and harmonization of objectives with resources; information processing are the result of decision by a person or group of people. Decision making is the essence of the management process. There are different decision models in circumstances of certainty, the most frequent encountered are: the ELECTRE Method, Global Utility Method and the Onicescu Method.

For the purpose of the research developed in the context of virtual teams management, the present paper tackles the ELECTRE I method, because when the decider knows for sure which the functionalities and outcomes are (and can easy quantified them) in association with each software tools, the decision making process is under conditions of certainty.

## 2.1. ELECTRE METHOD – BRIEF DESCRIPTION

ELECTRE method (Elimination et Choix Traduisant la Réalité), developed by Bertrand Roy in 1964 (Oprean et al., 1985), represents a tool for optimizing decisions under certainty. Bernard Roy is recognized as father of the ELECTRE method because he has one of the earliest approaches in what is sometimes known as the French School of decision making. ELECTRE is usually classified as an "outranking method" of decision making. After the first version ELECTRE I (Roy, 1968), the method has evolved into a number of other variants: ELECTRE II (Roy and Bertier, 1971, 1972), ELECTRE III (Roy, 1978), ELECTRE IV, ELECTRE IS and ELECTRE TRI (ELECTRE tree); another variant of the ELECTRE approach is the TOPSIS method (Hwang and Yoon, 1981).

ELECTRE is based on the concept of upgrades for eliminate alternatives that are in some sense *dominated*. The notion of *dominance* in the framework of the upgrades means a generalization of classical dominance weights used to rank the criteria (some of them have more influence than others on the decision). ELECTRE methods allows deciders to choose a variant of a *n* number of possible options by taking into account all factors (criteria) of quantitative and qualitative influence - the decision base on favorable or unfavorable spaces of different alternatives. This method consists of two main procedures: (1) construction of one or several outranking relation(s) followed by (2) an exploitation procedure (Figueira et. al., 2005). The main steps of a decision making process according to the ELECTRE method, are summarized in Figure 1.

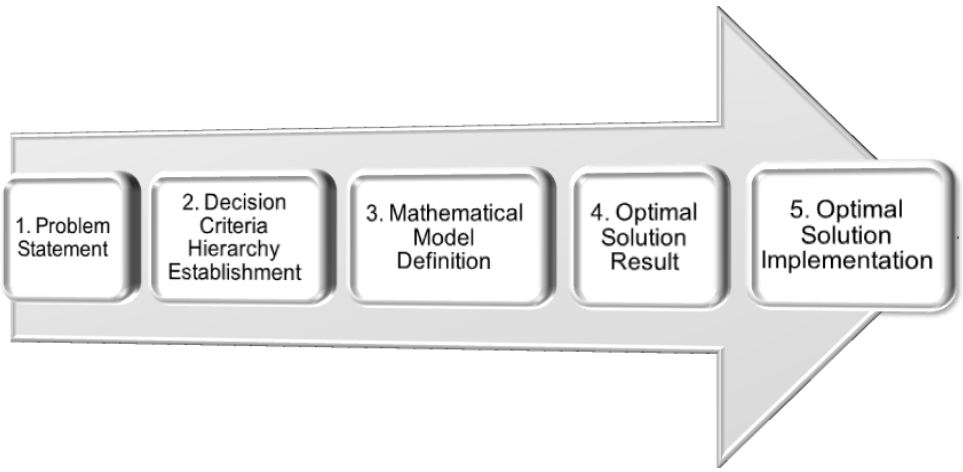


***Figure 2. Steps of Appling ELECTRE Methods.***

## 2.2. ELECTRE METHOD USED TO SUPPORT THE DECISION MAKING PROCESS OF CHOOSING THE RIGHT ICT SOLUTION FOR A VIRTUAL TEAM

**1. Problem statement** – in the previous research there have been defined and analyzed the main functionalities that are needed for a software solution to better support the collaborative environment of a virtual team. This analysis was based by an exhaustive study related to existing software solution available on the market, that were tested (trial versions or free versions). In Table 1 are shown the different type of software solution that have been consider for the decision making process and in Table 2 are the functionalities needed to support virtual teams' collaborative environment (Aldea, Draghici, 2012).

**Table 1. The Software Solutions Analyzed.**

| No. | sm | Software |
|---|---|---|
| 1 | s1 | AnyMeeting |
| 2 | s2 | Arel Spotlight |
| 3 | s3 | Enovia 3D Live |
| 4 | s4 | EVO |
| 5 | s5 | Live Meeting |
| 6 | s6 | Lotus Sametime |
| 7 | s7 | Skype |
| 8 | s8 | WebEx |

**Table 2. The Functions Related to the Software Solutions Analyzed.**

| No. | fn (functionalities) | Brief description of the functionality |
|---|---|---|
| 1 | f1 | instant messages |
| 2 | f2 | sound transmission |
| 3 | f3 | video transmission |
| 4 | f4 | whiteboard |
| 5 | f5 | common control of the application |
| 6 | f6 | transmitting data through files |
| 7 | f7 | generate detailed report |
| 8 | f8 | conducting a survey |
| 9 | f9 | showing the participation |
| 10 | f10 | capacity, number of participants |
| 11 | f11 | recording session |
| 12 | f12 | annual cost |
| 13 | f13 | application security |

The number and type of criteria/functionalities considered vary in proportion to the complexity of the process or with the aims of the decider (the manager): a11, b12, ..., h1j, ..., t1m are variant values in all 1, 2, ..., m criteria/functionalities considered; k1, k2, ..., kj, ..., km importance given to criteria/functionalities and factors that may have equal size for two or more criteria/functionalities. These criteria/functionalities can be of two categories according to their appreciation as follows: (a) quantitative criteria when their expression is achieved by means of physical quantities, values and conventional; (b) quality criteria when their expression is performed using qualifications. The weights associate to the criteria is p = {0, 0.5, 1}.

## 2. DECISION CRITERIA HIERARCHY ESTABLISHMENT (SEE TABLE 3 THE CALCULATIONS RESULTS)

**Table 3. The Decision Matrix for Choosing the Right Software Tool.**

| Function / Software | f1 | f2 | f3 | f4 | f5 | f6 | f7 | f8 | f9 | f10 | f11 | f12 | f13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **s1** | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 200 | 1 | 0 Euro | 1 |
| **s2** | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 200 | 1 | 0 euro | 1 |
| **s3** | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | ∞ | 1 | 196 euro | 1 |
| **s4** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | ∞ | 1 | 0 Euro | 1 |
| **s5** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1200 | 1 | 49 euro/host | 1 |
| **s6** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 200 | 1 | 159 euro | 1 |
| **s7** | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | ∞ | 0 | 0 Euro | 1 |
| **s8** | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | >200 | 1 | 228 euro | 1 |

After the decision matrix have been define, there have to be established the criteria importance coefficients. This is done using the selection matrix of the criteria. Table 4 and 5 shows the results of this approach – the method of criteria/functions comparison. All the calculations done were based on the Excel program.

**Table 4. The Criteria Importance Coefficients Matrix.**

| Function | f1 | f2 | f3 | f4 | f5 | f6 | f7 | f8 | f9 | f10 | f11 | f12 | f13 | Σk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **f1** | X | 0.5 | 1 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | **8.5** |
| **f2** | 0.5 | X | 1 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 0.5 | **9** |
| **f3** | 0 | 0 | X | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0 | **2.5** |
| **f4** | 0.5 | 0.5 | 1 | X | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 0.5 | **8.5** |
| **f5** | 0.5 | 0.5 | 1 | 0.5 | X | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 0.5 | **9** |
| **f6** | 0.5 | 0.5 | 1 | 0.5 | 0.5 | X | 0.5 | 1 | 0.5 | 1 | 0.5 | 1 | 0.5 | **8** |
| **f7** | 0 | 0 | 0.5 | 0.5 | 0 | 0.5 | X | 0 | 0.5 | 0.5 | 0.5 | 1 | 0.5 | **4.5** |
| **f8** | 0 | 0 | 0.5 | 0 | 0 | 0 | 1 | X | 0 | 0.5 | 0 | 0 | 0 | **2** |
| **f9** | 0 | 0 | 0.5 | 0 | 0 | 0.5 | 0.5 | 1 | X | 0.5 | 0.5 | 0.5 | 0.5 | **4.5** |
| **f10** | 0 | 0 | 0.5 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | X | 0.5 | 0.5 | 0.5 | **3.5** |
| **f11** | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | X | 1 | 0.5 | **7.5** |
| **f12** | 0.5 | 0 | 0.5 | 0 | 0 | 0 | 0 | 1 | 0.5 | 0.5 | 0 | X | 0.5 | **3.5** |
| **f13** | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | X | **7** |

**Table 5. The Coefficients Rank.**

| Importance | Value | Function |
|---|---|---|
| **1 (most important)** | 9 | - sound transmission, f1<br>- common control of the application, f5 |
| **2** | 8.5 | - instant messages, f1<br>- whiteboard, f4 |
| **3** | 8 | - transmitting data through files, f6 |
| **4** | 7.5 | - recording session, f11 |
| **5** | 7 | - application security, f13 |
| **6** | 4.5 | - generate detailed report, f7<br>- showing the participation, f9 |
| **7** | 3.5 | - capacity, number of participants, f10<br>- annual cost, f12 |
| **8** | 2.5 | - video transmission, f3 |
| **9 (less important)** | 2 | - conducting a survey, f8 |

For functions f10 and f12 are set corresponding qualifications to certain ranges of values as interests of the decider. In our case as follows:

- For simultaneous participants/users ≤ 200 persons of a virtual work session f10 = 0;
- For simultaneous participants/users 200 ÷ 1200 persons, f10 = 0.5;
- For simultaneous participants/users > 1200 persons f10 = 1;
- f12 = 0 in the case of free or open source applications and f12 = 1 in the case of license applications.

The qualifications matrix is shown in Table 6.

**Table 6. The Qualifications Matrix.**

| Function / Software | f1 | f2 | f3 | f4 | f5 | f6 | f7 | f8 | f9 | f10 | f11 | f12 | f13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **s1** | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| **s2** | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| **s3** | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| **s4** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| **s5** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0.5 | 1 | 1 | 1 |
| **s6** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| **s7** | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| **s8** | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.5 | 1 | 1 | 1 |
| **Σk** | **8.5** | **9** | **2.5** | **8.5** | **9** | **8** | **4.5** | **2** | **4.5** | **3.5** | **7.5** | **3.5** | **7.5** |

**3. MATHEMATICAL MODEL DEFINITION** is given by the concordance/ discordance matrix. The concordance formula is: $$C_{cik} = \frac{\sum_{Ni \geq Nk} K_j}{\sum_{j=1}^{8} K_j},$$ (1)

where $\sum_{Ni \geq Nk} K_j$ is the sum of the coefficients of importance criteria concordance for the mark given to the variable *i* if it is higher or at least equal to the mark given variant *k*, and $\sum_{j=1}^{8} K_j$ is the sum of all importance coefficients. The matrix of concordance indices is shown in Table 7. The discordance indices for all the alternatives is calculated, in terms of each one of the decision criteria according to the following formula: $C_{dik} = \frac{\max \Delta d}{\Delta h \max}$, (2)

where $\Delta d$ is the discordant interval for a criterion in which the appreciation of the *k* variable is superior to variant *i,* Nk > Ni, so: $\Delta d = Nk - Ni$, and $\Delta h \max$ is the maximum difference between the maximum and minimum mark on grading scales. The matrix of discordance indices is shown in Table 8.

**Table 7. The Concordance Matrix.**

| | v1 | v2 | v3 | v4 | v5 | v6 | v7 | v8 |
|---|---|---|---|---|---|---|---|---|
| **v1** | X | 1 | 0.87 | 0.97 | 0.97 | 1 | 0.77 | 0.82 |
| **v2** | 0.94 | X | 0.81 | 0.97 | 0.97 | 1 | 0.71 | 0.82 |
| **v3** | 0.80 | 0.80 | X | 0.96 | 0.96 | 0.96 | 0.86 | 0.85 |
| **v4** | 0.78 | 0.84 | 0.83 | X | 0.96 | 0.96 | 0.74 | 0.80 |
| **v5** | 0.74 | 0.80 | 0.83 | 0.96 | X | 0.96 | 0.69 | 0.84 |
| **v6** | 0.78 | 0.84 | 0.81 | 0.78 | 0.97 | X | 0.67 | 0.82 |
| **v7** | 0.84 | 0.84 | 1 | 1 | 0.96 | 0.96 | X | 0.85 |
| **v8** | 0.80 | 0.80 | 0.89 | 0.96 | 1 | 0.96 | 0.75 | X |

**Table 8. The Discordance Matrix.**

| | v1 | v2 | v3 | v4 | v5 | v6 | v7 | v8 |
|---|---|---|---|---|---|---|---|---|
| **v1** | X | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| **v2** | 1 | X | 1 | 1 | 1 | 0 | 1 | 1 |
| **v3** | 1 | 1 | X | 1 | 0 | 1 | 1 | 1 |
| **v4** | 1 | 1 | 1 | X | 0 | 1 | 1 | 1 |
| **v5** | 1 | 1 | 1 | 1 | X | 0.5 | 1 | 1 |
| **v6** | 1 | 1 | 1 | 1 | 1 | X | 1 | 1 |
| **v7** | 1 | 1 | 0 | 0 | 0 | 1 | X | 1 |
| **v8** | 1 | 1 | 0 | 1 | 0 | 0.5 | 1 | X |

Matrix differences (Table 9) is calculate according to the relationship:

$$C_{cik} - C_{dik} \tag{3}$$

**Table 9. The Differences Matrix.**

| | v1 | v2 | v3 | v4 | v5 | v6 | v7 | v8 |
|---|---|---|---|---|---|---|---|---|
| **v1** | X | -0.06 | -0.20 | -0.22 | -0.26 | -0.22 | -0.16 | -0.20 |
| **v2** | 1 | X | -0.20 | -0.16 | -0.20 | -0.16 | -0.16 | -0.20 |
| **v3** | -0.13 | -0.19 | X | -0.17 | -0.17 | -0.19 | 1 | 0.89 |
| **v4** | -0.03 | -0.03 | -0.04 | X | -0.04 | -0.22 | 1 | -0.04 |
| **v5** | -0.03 | -0.03 | 0.96 | 0.96 | X | -0.03 | 0.96 | 1 |
| **v6** | 1 | 1 | -0.04 | -0.04 | 0.46 | X | -0.04 | 0.46 |
| **v7** | -0.23 | -0.29 | -0.14 | -0.26 | -0.31 | -0.33 | X | -0.25 |
| **v8** | -0.18 | -0.18 | -0.15 | -0.20 | -0.16 | -0.18 | -0.15 | X |

Finally, the classifying variants matrix with coefficients 0 and 1, is build with respect of the relationship: $C_{cik} - C_{dik} > C_{cki} - C_{dki}$ (4)

**Table 10. The Variants Matrix with Coefficients 0 and 1.**

| | v1 | v2 | v3 | v4 | v5 | v6 | v7 | v8 | **Σ"1"** |
|---|---|---|---|---|---|---|---|---|---|
| **v1** | X | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **7** |
| **v2** | 0 | X | 1 | 1 | 1 | 1 | 1 | 1 | **6** |
| **v3** | 1 | 1 | X | 1 | 1 | 1 | 0 | 0 | **5** |
| **v4** | 1 | 1 | 1 | X | 1 | 1 | 0 | 1 | **6** |
| **v5** | 1 | 1 | 0 | 0 | X | 1 | 0 | 0 | **3** |
| **v6** | 0 | 0 | 1 | 1 | 1 | X | 1 | 0 | **4** |
| **v7** | 1 | 1 | 1 | 1 | 1 | 1 | X | 1 | **7** |
| **v8** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | X | **7** |

**4. OPTIMAL SOLUTION RESULT** - This analysis indicates that after building the matrix of classifying variants, the final ranking of the optimal software solution is shown in Figure 3.

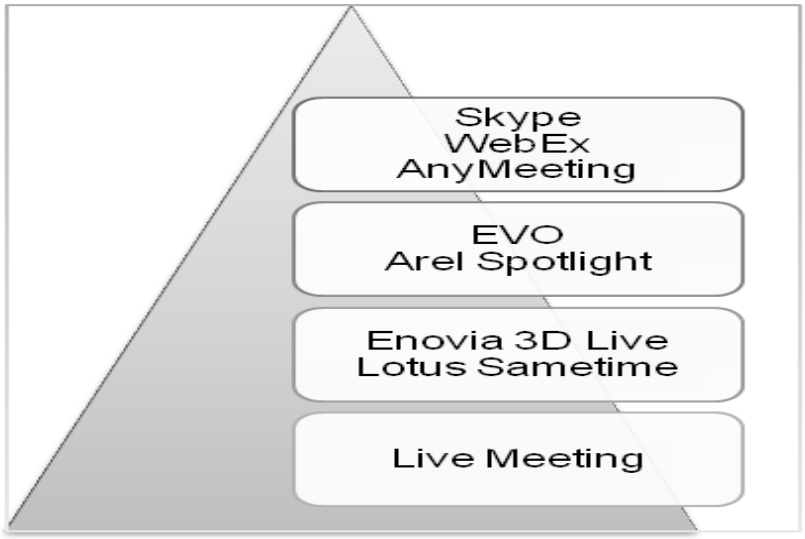


***Figure 3. Ranking of Software Solutions Analyzed.***

As it can be seen from the calculations results and Figure 3, software solutions as Skype, WebEx and AnyMeeting are considered the right solutions to define the collaborative environment of virtual teams. On the second place, decider has to be oriented upon EVO and Arel Spotlight applications and on the third place is Enovia 3D Live and Lotus Sametime.

## 2.CONCLUSIONS - OPTIMAL SOLUTION IMPLEMENTATION

Virtual teams are deeply dependent of ICT. These technologies define the operational-collaborative environment of any virtual team and thus come together to determine the infrastructure for collaborative working and learning. The actual virtual teams are using complex software tools to collaborate and to develop new complex tasks. During a project process that is developed by a virtual team, there are used a lot of software tools that are capable of project management and real-time communication between project teams or members.

The presentation made in this paper shows that structuring and modeling processes are important steps of any decision making process of choosing the right software solution to support virtual teams' activities.

Based on the results of the available software tools analysis that facilitate the collaboration between virtual teams members, it has been demonstrated that these tools support virtual work on specific projects, allows users to exchange information quickly and it leads to a decreased time required for attending complex tasks. In this context, the ELECTRE I method was applied to define and support the decision making process of choosing the right software solution. The approach highlighted that decider has to deeply analysis and define the software functionalities and he must consider the particularities of different software solution (advantages and disadvantages in realizing each functionality), which facilitates the access to information technologies, data storage and networking between virtual teams and members. Even it was mathematically demonstrated that certain software programs are the optimal solutions (Skype, WebEx and AnyMeeting) for defining the collaborative environment of virtual teams, in practice there have to be consider other specific conditions and/or requirements.

## 3.ACKNOWLEDGEMENTS

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