U.P.B. Sci. Bull., Series C, Vol. 81, Iss. 1, 2019 ISSN 2286-3540

DEVELOPMENT OF A KPI EVALUATION APPLICATION FOR SMALL AND MEDIUM SIZED COMPANIES

Marian GHEORGHE[1], Markus MORITZ[2], Aurel TARARA[3]

The Social Network Analysis process presents the characteristics of social structures for evaluating the relationship entity describing its nodes and connections. In a business-related environment there is a strong demand to extend or replace the typical Social Network Analysis output with a practical framework that combines network based KPIs (key performance indicators) with a company's commercial information. The present paper contributes to the design of a business based Social Network Analysis KPI model, as well as a software application for enhancing strategic and operational decision-making processes in a network environment. The achieved application can be included in the companies' KPI framework, as a key tool of business network evaluation for small and medium sized companies. The application is facile for different users, fast and easy to be maintained.

Keywords: Social Network Analysis, Networking Management, industry, Key Performance Indicator (KPI), framework

1. Introduction

In general, networks are mostly known in computer related definitions, where the meaning of ‚network' is an interconnection between two or more systems, like a computer or server. The main task is the exchange of information between those systems [1].

The main attributes of a network are interconnection and exchange of information between two or more systems. Interconnection means that a system is linked to another system, where the exchange of information describes a specific type of information delivered from one system to another. But this information is not necessarily delivered in a bi-directional way. Thus, interconnection means not only interaction, but - interpersonal communication, which is characterized by a bi-directional information flow.

[1] Professor, PhD, Doctoral School on Engineering and Management of Technological Systems, TCM Department, University POLITEHNICA of Bucharest, Romania, marian.gheorghe@upb.ro

[2] PhD Candidate, Doctoral School on Engineering and Management of Technological Systems, University POLITEHNICA of Bucharest, Romania/ Germany, markus.moritz@erichsen.de

[3] PhD Candidate, Doctoral School on Engineering and Management of Technological Systems, University POLITEHNICA of Bucharest, Romania, aurel.tarara@gmail.com

A network is described as a set of relations among specific objects, which can be drawn and defined on basis of these relations. The simplest one has two objects and one link [2].

In network theory there are several specific terms used to describe a network, like (a) node/actor/object: could be a single person, a group of persons. In a business environment, it may be used to describe a company, a function, business unit; (b) network/ graph: can be differentiated by undirected versus directed, and consists of a set of nodes; (c) link/ tie: connection between two different actors; (d) density: level of connectedness; (e) degree centrality: number of ties; (f) closeness centrality: total distance between one node and other nodes; (g) betweenness centrality: number of shortest paths [3].

An interpersonal bi-directional exchange of information between two systems is a main characterization of networks. Information is not only a simple content of semantic data, it is a complex combination of a certain set of different kinds of information, like emotional support and advice leading to an exchange of resources between actors in social networks [4].

Further, a specific characteristic of networks is the decentralization of performance and decision-making where a network generally has no centre working on an inclusion and exclusion logic (if something is useful for the network: inclusion; if something is not necessary for the network: exclusion) [5].

Also, the importance of a node to the network plays a significant role, where the value of information or the closeness, as being a central point of contact, can be a key dimension [6].

One main attribute of a network between certain nodes is the ability to react very flexible to environmental changes. Therefore, a network can also be described as a dynamic system or compared to biological systems like neurons in the human brain. Whenever an environmental change has an impact on a network node, the network itself is able to rearrange its settings [5]. And this is especially when it comes to knowledge sharing, where nodes that contribute more than others can be identified and must be supported [7].

Special software is used to map a social network and to perform Social Network Analysis (SNA). There is a variety of different software in the market with different visualization patterns and characteristics. Some of them are free and most of them are commercial [8].

The software's objectives may vary, but the overall aim is to visualize nodes and ties focusing on SNA key metrics like closeness and actor location. One application with a high usability is called NetMiner because of its data visualization and data management procedures, where especially users which are new to SNA find an easy to handle tool [9].

2. Objective and method of research

Under a new business network framework, small and medium sized company networks can be evaluated through analyzing *nodes* connected by relations with *positive*, *negative* or *neutral rational/ emotional* influence.

The objective of the present research is to develop a KPI evaluation application for small and medium sized companies by using a new business relationship network framework.

The present research has been approached with regard to a new business network, general node significance, selection of the programming language, the application main structural components and operating actions, as well as the evaluation of the application performance.

3. Application design

Reference elements

It has been chosen to use coding algorithms of low complexity that allow the development of flexible, extendable, maintainable and easy to operate application in business analysis environments. The visual interface and code organization philosophy lead to robust, fast and independent applications with low system resources requirements. A network generic model type of triad is as presented in Fig. 1.

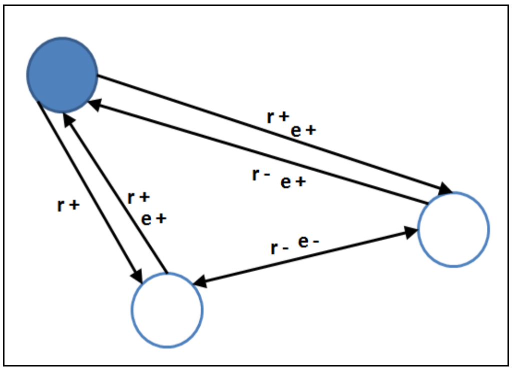

Fig.1. Triad with positive and negative rational/ emotional factors (r^+, r^-/ e^+, e^-)

The evaluation representation with positive and negative rational (r^+, r^-), as well as emotional (e^+, e^-) factors is a matrix where columns represent the data receiving nodes, the rows - the data sender nodes and the values - the relation state and the rational or emotional influence. The highest calculated value of a relation between two nodes describes a very good relation, where the lowest value describes a weak relation.

Relations between nodes are evaluated by means of a metrics system applied to the three possible states of the relation: no relation is established, NR, the relation is direct, DR, the relation is indirect, IR, the rational influence, RI, and the emotional influence, EI.

The evaluation matrix for direct relations of a network with three nodes is as presented in Fig. 2.

Companies	A	B	C
A		(DR x EI) + (DR x RI)	(DR x EI) + (DR x RI)
B	(DR x EI) + (DR x RI)		(DR x EI) + (DR x RI)
C	(DR x EI) + (DR x RI)	(DR x EI) + (DR x RI)	

Fig. 2. Evaluation matrix

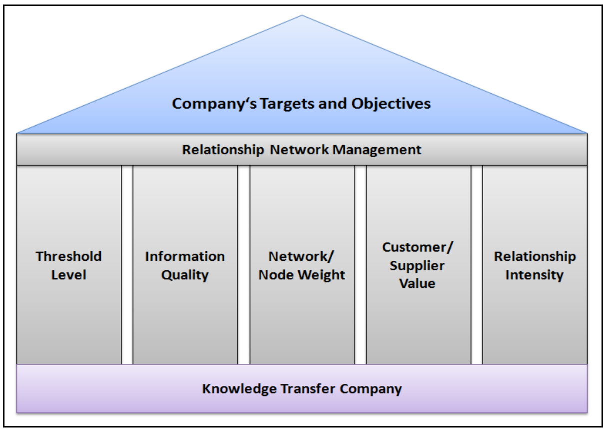

Fig.3. Five pillars of Relationship Network Management

To be noted that the *five pillars of relationship network management*, presented in Fig. 3, the business network analysis in terms of dependencies, the roles of nodes in the network, the nodes hierarchy level and the nodes value creation constitute the approach basis of the application development. The pillars build the operational framework for valuing nodes or a network. They play a significant role in analyzing internal, as well as external business relationship networks. In terms of dependencies business relation network can be analyzed considering different hierarchy levels in a company where the node itself transports the necessary information and their role in the decision-making process.

Considering the hierarchy, a node classification as presented in Fig. 4, a general description of node roles is presented in Fig. 5.

Fig. 4. Node hierarchy

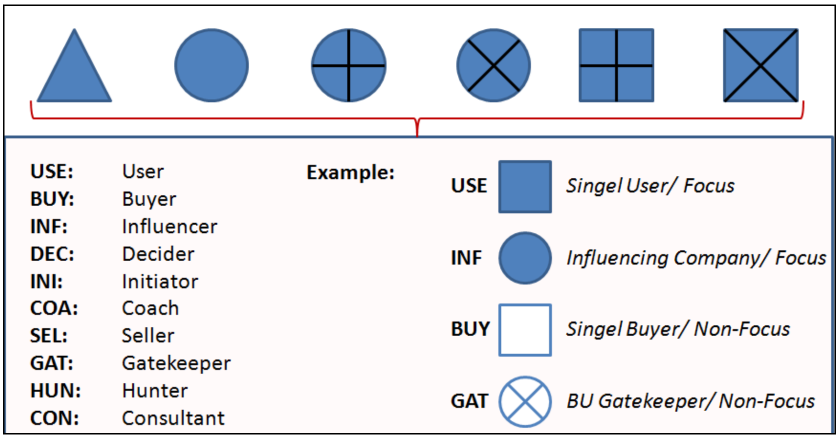

Fig. 5. Roles of a node classification

Application design elements

The application has been structured in two operational sections: the new entry operational section, ONE, and the search database operational section, ODS, defined in relation with the two nodes of the business network - main actor types following the previous model. These two sections show the possibility to perform an actor information entry and search the database (Fig. 6).

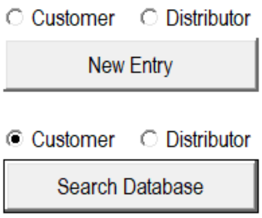

Fig. 6. Main interface

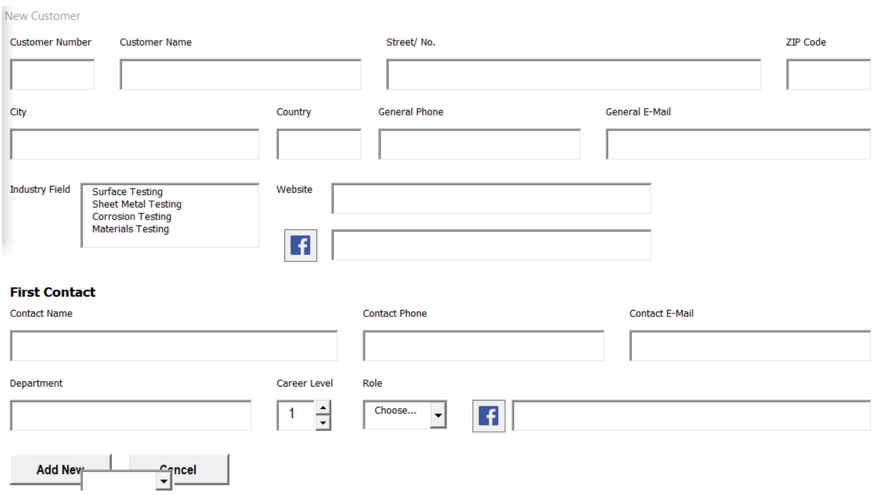

Fig. 7. Actor data entry user interface

The ONE has the operational role of storing the business network information. Data is saved in the application database, after the user has added the information in the ONE user interface, by the Add New action. The user interface is as presented in Fig. 7.

Node roles and hierarchy levels, as Career Level, are ONE required data transposed into coding variables with a structured algorithm as part of the business network analysis algorithm. The application database is structured, as follows: Welcome, Main Actor, Contact Base Actor, etc. The spreadsheets naming and column structure are in strict relation to the data type stored. The algorithm that allows the data to be stored is as follows:

```
void function SaveData {
if connection to database is not ok {
print "Connection not established";
return 1; }
else {
find first empty row in database;
store field_input field_database;
goto start;
return 0;
} }
```

The ODS has the operational role of database search and node/ business network analysis. Nodes database search is possible by means of a search user interface integrated in the ODS, presented in Fig. 8. The operational role of database search is achieved after the selection of the node name/ code.

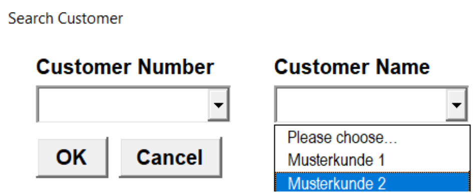

Fig. 8. ODS database search user interface

After the operational database search is completed, the operational node/ business network analysis is achieved and relevant data is presented to the user in an ODS tabular presentation user interface.

The general information representation of the user interface presents key data of the searched node e.g. company name, etc. Information update and node deletion is possible by means of *Save* and *Delete* actions. The network node analysis is achieved by the ODS by calculation of the node ratios, on a dyad basis. Results are presented in the node ratios tabular representation (Fig. 9).

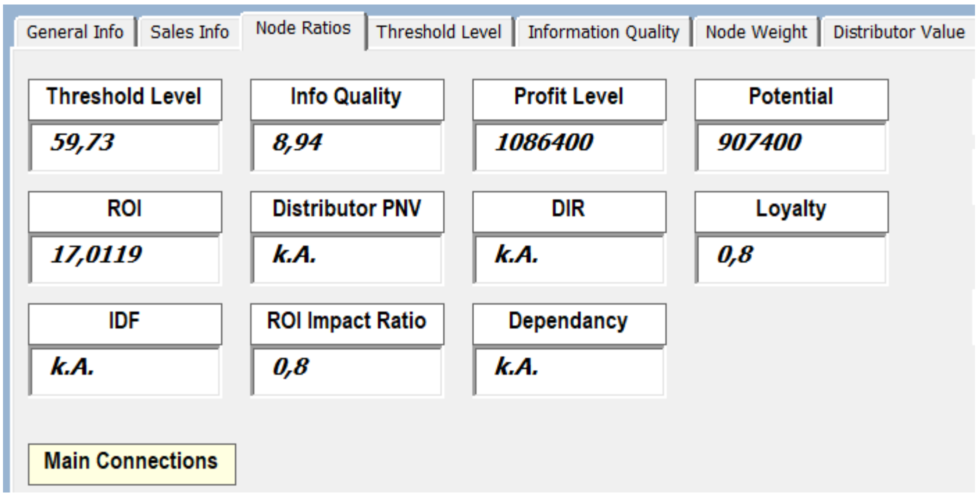

Fig. 9. Actor data base - Node Ratios section

The ODS calculation algorithm analyses specific node data previously registered into the database by means of the ONE section of the application.

An important KPI is the Threshold Level, TL, which answers the question if an actor is willing to enter into a relationship with another actor.

In order to calculate the total value of TL, different ratio values are assigned to the store locations in the database, based on the relation:

$$TL = \frac{TW * TS - CRV}{TW * TS} 100$$

where TL is the Threshold Level, in %, TW – Threshold Weight, in % , TS - Threshold Scoring in scoring points out of the scoring model, and CRV - Customer Restrictions Value in scoring points.

Analysis algorithm main subroutine are as follows:

```
void function network_kpi_calc {
for (i = 1; i = last input in row; i++) {
add input from textBox to database; }
tl = ratio_function(CRV) in database;
   add input to database;
   print tl; }
```

Another important KPI is the Customer Investment Rate, CIR, reflecting the investment capacity of an actor.

The total value of CIR is determined based on the relation:

$$CIR = \frac{CPRO + CPO}{TCEX} 100$$

where CIR is the Customer Investment Rate, in %, CPRO - Customer Profit, in EUR, CPO - Customer Potential, in EUR, and TCEX - Total Customer Expenses, in EUR, applied in the following subroutine:

```
void function CIR_Calculation {
crpo = database_value;
cpo = database value;
tcex = sum_function(row, column)
in database;
if tcex = 0 {
print “No value found”; }
   add input to database;
   print tcex
}
```

The result is visualized in the assigned actor’s section with the database as a source element (Fig. 9).

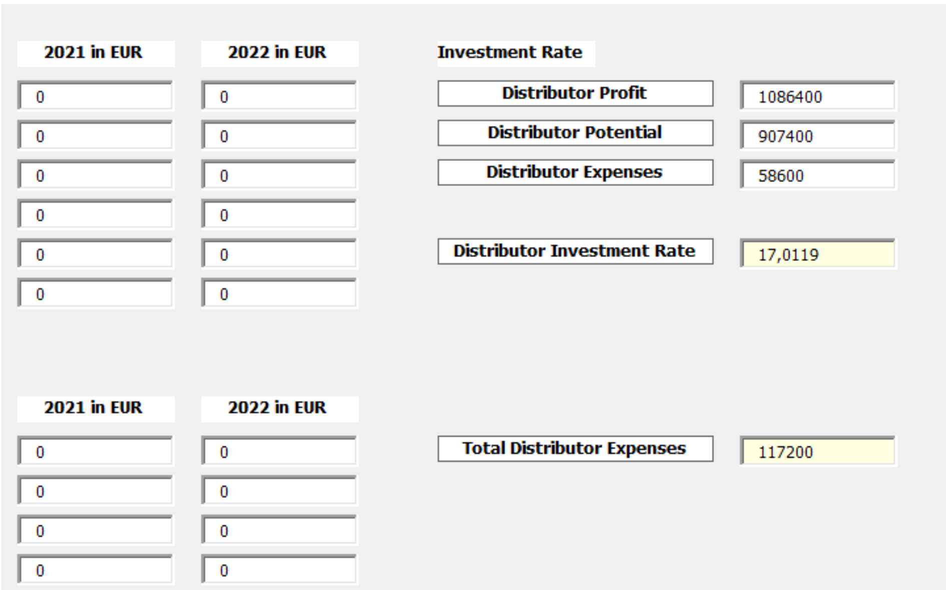

Fig. 10. Actor data base - Actor Value section

The advanced analysis main results, presented in the ODS tabular representation (Fig. 10), the Actor Profit and the Actor Potential, as well as Actor Total Expenses resulting in the Actor Investment Rate, are key factors in evaluating the actual node performance and in the business, decision-making process.

Performance of the achieved application

Taking advantage of well-structured and high-performance algorithms, as well as characteristics and function of an isolated solution, the achieved application has a low system resource usage and does not depend on third-party information systems e.g. servers.

The application is facile for different users. Its workflow is structured in such a way that the application can be maintained in a fast and easy way.

By the operational section ONE, data registration is achieved in a structured arrangement of database sections in order to be available for the node/ network analysis and to achieve a fast workflow with KPI interaction and to be able for further import functions. By the operational section ODS, registered database node information can be selected, analyzed and changed in order to calculate key data, at any time by the user.

The application result is a key information for business network evaluation associated to small and medium sized companies, reducing the time needed in the managerial decision-making process.

4. Conclusions

The first approach of a network evaluation tool has been designed on a new network KPI framework basis combined with commonly used commercial metrics. The application can be easily extended by more features using self-made functions or premade third-party tools.

Generally, applications built with low complexity algorithms and functions have a great usability and thus, coding is more or less simple to understand and can also be used to link to other applications in the same software framework and even in different software solutions by using built-in transfer functions.

This application now shows the most important KPIs, where strategies can be assessed with and formalized in relation to them. The new application can be included in the companies' KPI framework, for the yearly strategy board meetings, rating scenarios, etc.

REFERENCES

[1]. *S. Ahlawat, A. Anand*, An Introduction to Computer Ntworking, Int. J. of Computer Science and Information Technology Research, Vol. 2, Issue 2, pp. 373-377, www.researchpublish.com, 2014 (accessed on 16.07.2018).

[2]. *F. Boos, A. Exner*, *B. Heitger*, Soziale Netzwerke sind anders, „Social Network are different“, Organizational Development, Issue 11, No. 1, pp. 54 – 61, 1992.

[3]. *** mwlib, Social Network Analysis – Theory and Applications, https://www.politaktiv.org/documents/10157/29141/SocNet_TheoryApp.pdf (accessed on 14.08.2018).

[4]. *Y. Song*, From Offline Social Networks to Online Social Networks: Changes in Entrepreneurship, Informatica Economica, Vol 19, No. 2, 2015.

[5]. *K. S. Cook, R. M. Emerson, M. R. Gillmore, T. Yamagishi*, The Distribution of Power in Exchange Networks: Theory and Experimental Results, J. of Sociology, Vol. 89, No. 2, pp. 275-305, http://www.jstor.org/stable/2779142, 1983 (accessed on 16.07.2018).

[6]. *W. Liu, A. Sidhu, A. M. Beacom, T. W. Valente*, Social Network Theory, The International Encyclopedia of Media Effects, John Wiley & Sons, 2017.

[7]. *A. Cetto, J. Klier, M. Klier, A. Richter, K. Wiesneth*, The Blessing of Giving: Kowledge Sharing and Knowledge Seeking in Enterprise Social Networks, Research Papers, 2016, https://aisel.aisnet.org/ecis2016_rp/64 (accessed on 05.08.2018).

[8]. *P. Shah, Dr. R. Mehta*, Comparative Analysis of Social Network Analysis and Visualisation Tools, IJSRSET Engineering and Technology, Volume 3, Issue 1, 2017.

[9]. *M. Huisman, M. A. J. van Duijn*, A Reader’s Guide to SNA Software, The SAGE Handbook of Social Network Analysis, London, SAGE, 2011.