

Neutrosophic cognitive maps for modeling project portfolio interdependencies

Ameirys Betancourt-Vázquez¹, Maikel Leyva-Vázquez²,
Karina Perez-Teruel²

¹ Instituto Superior Politécnico de Tecnologías e Ciências (ISPTEC)
Luanda, Angola
ameirysbv@gmail.com

² Universidad de las Ciencias Informáticas
La Habana, Cuba

Abstract

Interdependency modeling and analysis have commonly been ignored in project portfolio management. In this work, we proposed a new method for modeling project portfolio interdependencies, and specially risks interdependencies, using neutrosophic logic and neutrosophic cognitive maps. This proposal has many advantages for dealing with indeterminacy making easy the elicitation of knowledge from experts. An illustrative example is presented to demonstrate the applicability of the proposed method.

Keywords

Neutrosophic logic, Neutrosophic cognitive maps, Risk interdependencies, Project portfolio interdependencies.

1 Introduction

A portfolio of project is a group of project that share resources creating relation among them of complementarity, incompatibility or synergy [1]. The interdependency modeling and analysis have commonly been ignored in project portfolio management [2].

In an international survey only 38.6 % of responders understand this element [2]. Cost increasing, the lack of benefits exploitation [3] and the incorrect selection of projects [4] are among the consequences. In this work a proposal for modeling project portfolio risk interdependencies neutrosophic cognitive maps (NCM) [11] is developed.

This paper is structured as follows: Section 2 reviews some important concepts about neutrosophic cognitive maps and risks interdependencies modeling. In Section 3, we present a framework for modeling interdependencies in project portfolio risks. Section 4 shows an illustrative example. The paper ends with conclusions and further work recommendations in Section 5.

2 Neutrosophic cognitive maps and risks interdependencies

A fuzzy cognitive maps (FCM) [5] are fuzzy graph structures for representing causal knowledge. FCM have been applied to diverse areas such as decision support and complex systems analysis [6]. Furthermore multiples extensions have been developed such as fuzzy grey cognitive maps [7], interval fuzzy cognitive maps [8], Intuitionistic fuzzy cognitive maps [9] and linguistic 2-tuple fuzzy cognitive maps [10].

Neutrosophic cognitive maps (NCM) were created by Vasantha & Smarandache [11] as an extension of the Fuzzy Cognitive Maps (FCMs) in which indeterminacy is included using neutrosophic logic. Neutrosophic logic is a logic in which each proposition is estimated to have the percentage of truth in a subset T, the percentage of indeterminacy in a subset I, and the percentage of falsity in a subset F [12].

There are five types of project portfolio interdependencies: benefit, risk, outcome, schedule and resources [13]. Risks have a positive or negative correlation with others provoking risk diversification or amplification effects. In this work project portfolio risk interdependencies are modeled using neutrosophic logic to include indeterminacy.

3 Modeling project portfolio interdependencies

Our aim is develop framework for modeling project portfolio and its interrelation based NCM. The model consists of the following phases (graphically, *Figure 1*):

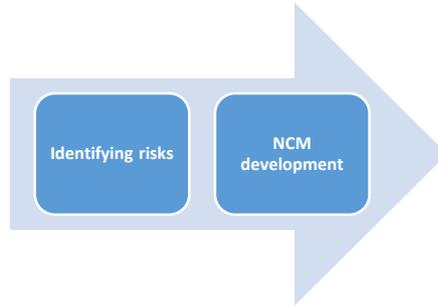


Figure 1. A Framework project portfolio risk interdependencies.

Identifying risks

The first step is the identification of risks. Risks are identified initially at project level. A portfolio risk breakdown structure with interdependencies is obtained. An example for a risk breakdown structure applicable to IT portfolios with interdependencies is shown in [13].

NCM development

The weight of the relationship among from given risk R_i to risk R_j is represented by means of neutrosophic logic. Additionally static analysis for selecting the most important risks could be developed [14].

4 Illustrative example

Five risks $R = (r_1, \dots, r_5)$ are identified at portfolio level (*Table 2*).

Table 1. Portfolio risks

Node	Description
R_1	Project 1 Technical feasibility
R_2	Project 1 Timely completion
R_3	Project 2 Timely completion
R_4	Project 2 Code quality
R_5	Project 3 Timely completion
R_6	Project 3 Cultural acceptance

Later, the expert provides the following interrelations (*Figure 2*):

$$W = \begin{matrix} & & 0 & 0 & 0.75 & 0 & 0 & 0 \\ & & 0 & 0 & 0.3 & 0 & 0 & 0 \\ & & 0 & 0 & 0 & 0 & 0 & 0 \\ & & 0 & 0 & 0 & 0 & 0 & 0 \\ & & 0 & 0 & 1 & 0 & 0 & 0 \\ & & 0 & 0 & 0.5 & 1 & 0 & 0 \end{matrix}$$

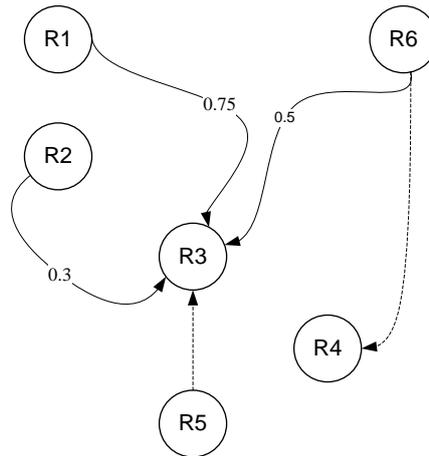


Figure 2. Neutrosophic cognitive map representing risks interdependencies.

In this example, the technical feasibility of project #1 (technical risk) could severely affect the timely completion of projects #2. Also, if no consistent tooling is used, and the agile development approach (project #3) is not culturally accepted, projects #2 are more likely to experience quality issues and time delay. Indeterminacy is introduced in project #3 risks interrelation with other risks of project #2.

5 Conclusion

This paper proposes a new framework to model interdependencies in project portfolio. NCM representation model is used for modeling relation among risks.

Building NCM follows an approach more similar to human reasoning introducing indeterminacy in relations. An illustrative example showed the applicability of the proposal. Further works will concentrate on two objectives: developing a consensus model, and extending the model to other areas of project portfolio interdependencies modeling.

6 References

- [1] Fernández Carazo, A., et al., *Evaluación y clasificación de las técnicas utilizadas por las organizaciones, en las últimas décadas, para seleccionar proyectos*. Revista de métodos cuantitativos para la economía y la empresa, 2008: p. 67–115.
- [2] Mors, M., R. Drost, and F. Harmsen, *Project Portfolio Management in Practice*. 2010, Springer. p. 107-126.

- [3] Sommerville, I., *Ingeniería del Software*. Séptima Edición ed ed. 2005, Madrid: Pearson Educación.
- [4] Kundisch, D. and C. Meier. *IT/IS Project Portfolio Selection in the Presence of Project Interactions–Review and Synthesis of the Literature*. In *Wirtschaftsinformatik Proceedings 2011*. 2011.
- [5] Kosko, B., *Fuzzy cognitive maps*. *International Journal of Man-Machine Studies*, 1986. 24(1): p. 65-75.
- [6] Leyva Vázquez, M.Y., et al., *Modelo para el análisis de escenarios basados en mapas cognitivos difusos: estudio de caso en software biomédico*. *Ingeniería y Universidad*, 2013. 17(2): p. 375-390.
- [7] Salmeron, J.L., *Modelling grey uncertainty with Fuzzy Grey Cognitive Maps*. *Expert Systems with Applications*, 2010. 37(12): p. 7581-7588.
- [8] Papageorgiou, E., C. Stylios, and P. Groumpos, *Introducing Interval Analysis in Fuzzy Cognitive Map Framework Advances in Artificial Intelligence*, G. Antoniou, et al., Editors. 2006, Springer Berlin / Heidelberg. p. 571-575.
- [9] Iakovidis, D.K. and E. Papageorgiou, *Intuitionistic Fuzzy Cognitive Maps for Medical Decision Making*. *Information Technology in Biomedicine, IEEE Transactions on*, 2011. 15(1): p. 100-107.
- [10] Pérez-Teruel, K., et al., *Computación con palabras en la toma de decisiones mediante mapas cognitivos difusos*. *Revista Cubana de Ciencias Informáticas*, 2014. 8(2): p. 19-34.
- [11] Kandasamy, W.B.V. and F. Smarandache, *Fuzzy Cognitive Maps and Neutrosophic Cognitive Maps*. 2003: Xiquan.
- [12] Smarandache, F., *Neutrosophic Logic. A Generalization of the Intuitionistic Fuzzy Logic*. 2003.
- [13] Arlt, M., *Advancing the maturity of project portfolio management through methodology and metrics refinements*. 2010, RMIT University.
- [14] Pérez-Teruel, K. and M. Leyva-Vázquez, *Neutrosophic logic for mental model elicitation and analysis*.