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ICDSST 2016 PROCEEDINGS – THE EWG-DSS 2016 INT. CONFERENCE ON DECISION SUPPORT SYSTEM TECHNOLOGY: DECISION SUPPORT SYSTEMS ADDRESSING SUSTAINABILITY & SOCIETAL CHALLENGES
Shaofeng Liu, Boris Delibašić, Isabelle Linden, Festus.O. Oderanti, (editors)
Plymouth, United Kingdom, 23-25 May 2016

ICDSST 2016: Decision Support Systems: Addressing Sustainability & Societal Challenges

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ABSTRACT

This article aims at analyzing financial investments from a risk point of view. The analysis is carried out by specifying, first, several financial operations typical of banking on a smaller scale, such as investing and extending credit and, second, several types of risk inherent in these activities. The risks are grouped into four criteria, operational risk, financial risk, management risk and external risk. The analysis is conducted using the PROMETHEE multi-criteria decision methodology. Professionals in risk management are trying to better appreciate the complexity of the financial activities under study, and have used complex models to do so, but nonetheless many risks are still not well understood. This article contributes to the risk analysis, delivering results that will help many financial institutions to improve the management of their financial operations, including micro-finance.

Keywords: MCDM, Risk Analysis, Bank Investment, PROMETHEE

INTRODUCTION

Our goal is to analyze the risks faced by financial institutions, including not only primary banks but also credit institutions engaged in micro-finance. Their activities, mainly collecting deposits and distributing credit, impact most of the population in developing countries, as well as the poor in developed countries. Our work is based on the use of the Multi-Criteria methodology PROMETHEE to analyze the risks for offering finance or investing, and depends on a specification of risks. Our objective is to support decision makers in financial institutions.

The risks faced by financial institutions depend on their economic activities and the environment in which they operate. Based on a literature review, we defined different four different categories of risk, operational risk, financial risk, counterparty risk, and external risk [1] [2]. These four categories were then subdivided into 19 subcriteria, as shown in Table 1.

Table 1: Different types of studied risks

Operational risk	Financial risk management	Counterparty risk	External risk
Risk of fraud	Currency risk	Liquidity risk	Country risk
Risk of Hold-up	Credit risk	Interest rate risk	Risk guarantee
Information risk	Risk Insider	Market risk	Concentration risk
Generic risk	Legal and regulatory risk	Solvency risk	Risk of recovery
Legal risk	Underwriting risk		Risk of exposure

The hierarchical structure defining the problem, given in Figure 1, clarifies the issues and shows the contribution of each element to the final decision. Eight alternatives, representing various financial operations, are shown on the right side of Figure 1. The criteria and subcriteria are the elements that should influence the choice of alternative. At this step the goal is to find the links among the criteria, the subcriteria, and the alternatives.

The hierarchial structure include four levels. Level 0 is the global objective, level 1 the criteria by which achievement of the global objective is assessed, level 2 the subcriteria of which the criteria are composed, and level 3 the alternatives that may be selected. In Figure 2,

Level 0 represents the aim to select a project from the set of all alternatives.
Level 1 represents the criteria for this analysis,
C_1 = operational risk
C_2 = financial risk management
C_3 = counterparty risk
C_4 = external risks.
Level 2 includes 19 sub-criteria, called SC1, SC2, …, SC19.
Level 3 includes 8 alternatives, called ALT1, ALT 2, …, ALT 9.

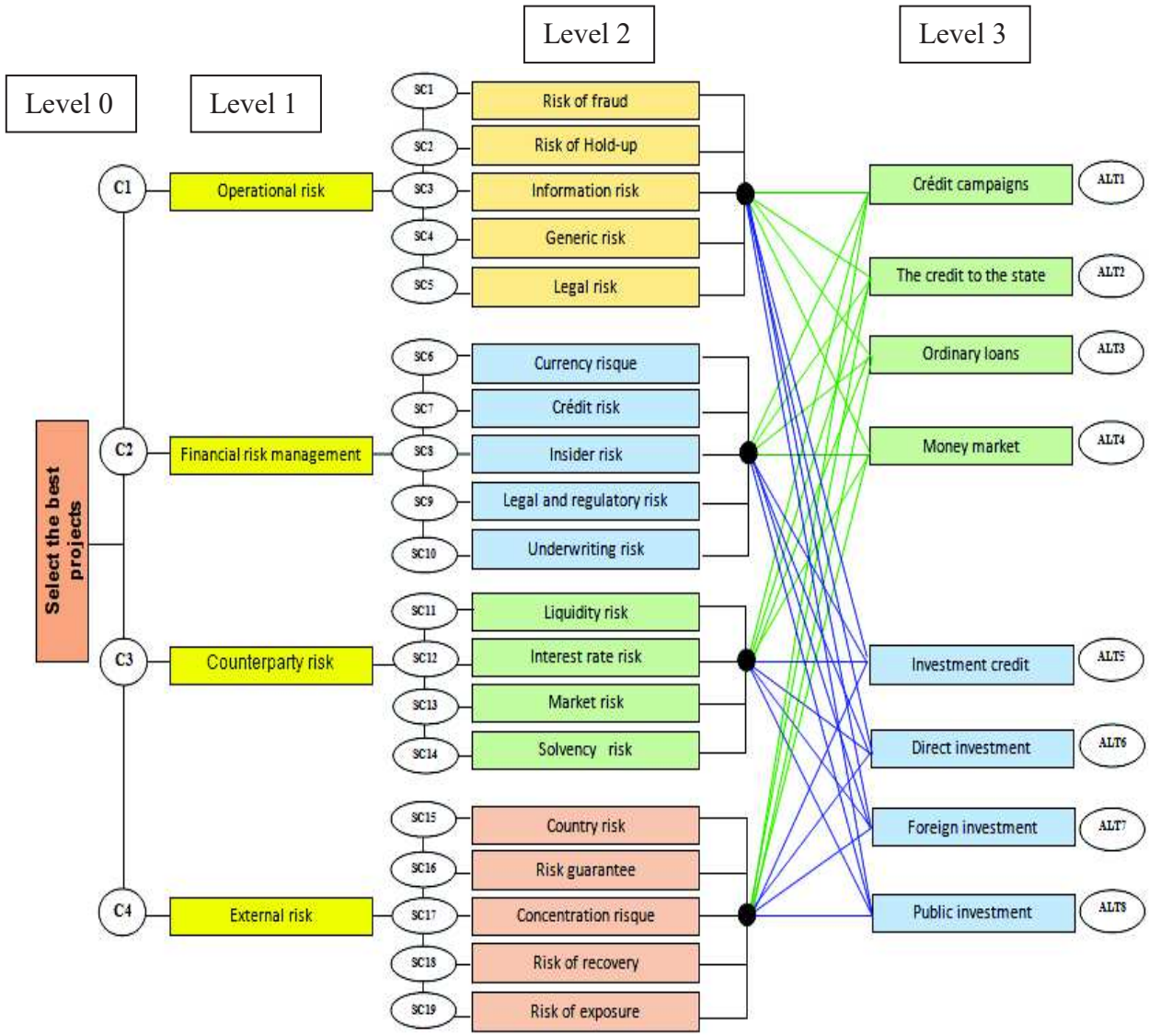


Figure 1: Complete graphical representation

APPLICATION OF PROMETHEE

The problem shown in Figure 1 was analyzed using the MultiCriteria Decision Method PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations). PROMETHEE rests on pairwise comparisons of pairs of alternatives on every criterion [3, 4, 5, 6]. It associates with each criterion, j, a relation $P_j(a, b)$ reflecting the preference for alternative a relative to alternative b on criterion j. The relation P_j contains all available information about the preferences of the decision maker on the criterion j.

The PROMETHEE method allows decision makers to choose from several forms of criteria. Because there are many subcriteria in this problem, we simplify the analysis by choosing a Form 1 ("usual" form) criterion, in which the value of $P_j(a, b)$ reflects whether alternatives a and b are judged as different. In Figure 2, the function H (with no parameters) reflects preference: whenever there is a difference, d, between the ratings of alternatives a and b, $H(d)= 1$; if there is no difference, $d = 0$, and $H(0) = 0$, and the decision maker is indifferent.

This function reflects the general case including Maximizing and Minimizing criteria.

$$\forall (a,b), \forall j \ (Critère) : P_j(a,b)$$

$$d_j(a,b) = f_j(a) - f_j(b)$$

$$\mathrm{H}(d) = \begin{cases} 0 & d = 0 \\ 1 & |d| > 0 \end{cases}$$

$H(d)$: Preference Function

Figure 2 : Preference Function: "Usual" Form

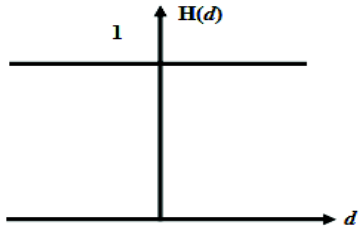


Table 2 below shows the weight values of the four criteria (C_1 – C_4) and the 19 subcriteria (SC1 – SC19) in the yellow-shaded columns, that were obtained in an earlier analysis using the AHP method [7]. The values of the project aggregations (shaded green) were obtained as the product of the weights of the corresponding criterion and sub-criterion. Because every criterion measures risk, we minimize all of them in order to find the best alternative.

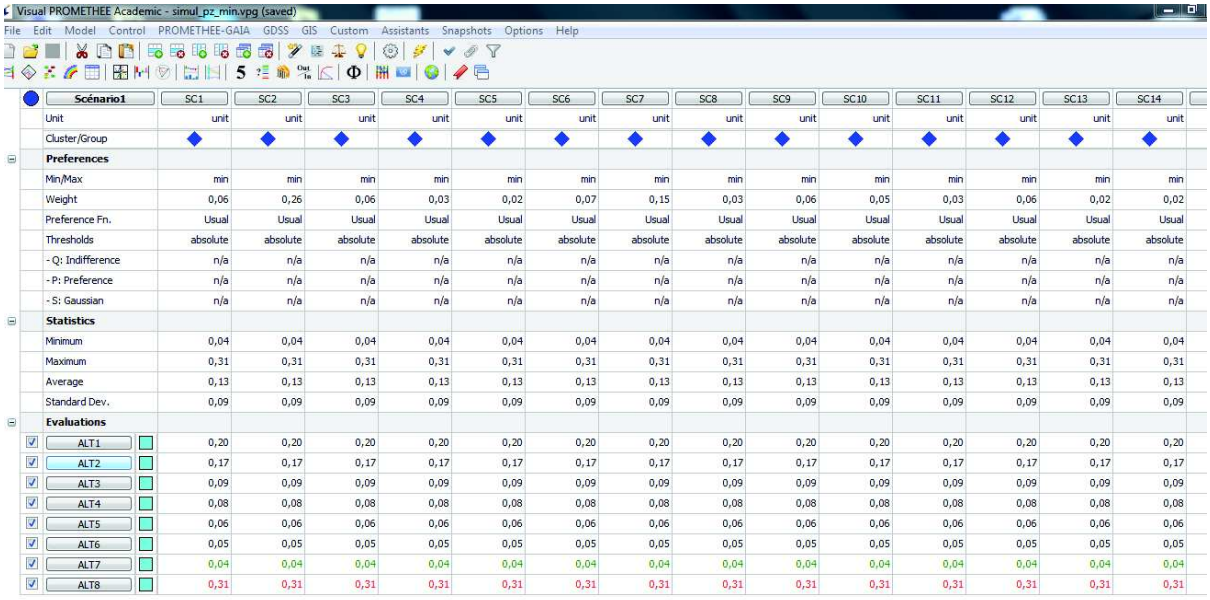
Criteria (C_i)		**Weights**	**Subcriteria (SCi)**		**Weights Performance criterion**	**Product of Weights** rounded to 2 decimal places
C_1	Operational risk	[0.434]	SC_1	Risk of fraud	[0.126]	[0.06]
			SC_2	Risk of Hold Up	[0.606]	[0.26]
			SC_3	Information risk	[0.141]	[0.06]
			SC_4	Generic risk	[0.075]	[0.03]
			SC_5	Legal risk	[0.052]	[0.02]
C_2	Financial risk management	[0.366]	SC_6	Currency risk	[0.194]	[0.07]
			SC_7	Credit risk	[0.417]	[0.15]
			SC_8	Insider risk	[0.089]	[0.03]
			SC_9	Legal and regulatory risk	[0.163]	[0.06]
			SC_{10}	Underwriting risk	[0.137]	[0.05]
C_3	Counterparty risk	[0.128]	SC_{11}	Liquidity risk	[0.238]	[0.03]
			SC_{12}	Interest rate risk	[0.514]	[0.06]
			SC_{13}	Market risk	[0.133]	[0.01]
			SC_{14}	Solvency risk	[0.115]	[0.01]
C_4	External risk	[0.072]	SC_{15}	Country risk	[0.489]	[0.04]
			SC_{16}	Risk guarantee	[0.202]	[0.02]
			SC_{17}	Concetration risk	[0.155]	[0.01]
			SC_{18}	Risk of recovery	[0.091]	[0.01]
			SC_{19}	Risk exposure	[0.063]	[0.01]

Table 2: Criteria Weights

RESULTS

The analysis is based on the 19 subcriteria. All eight alternatives are scored on a continuous scale [0,1]. The score of each alternative is determined from a first analysis conducted with AHP (see [7]).

Figure 3: Partial Performance Matrix



Scénario1	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13	SC14
Unit	unit	unit	unit	unit	unit	unit	unit	unit	unit	unit	unit	unit	unit	unit
Cluster/Group	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Preferences														
Min/Max	min	min	min	min	min	min	min	min	min	min	min	min	min	min
Weight	0,06	0,26	0,06	0,03	0,02	0,07	0,15	0,03	0,06	0,05	0,03	0,06	0,02	0,02
Preference Fn.	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- P: Preference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics														
Minimum	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
Maximum	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31
Average	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Standard Dev.	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09
Evaluations														
ALT1	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20
ALT2	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17
ALT3	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09
ALT4	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
ALT5	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06
ALT6	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
ALT7	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
ALT8	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31

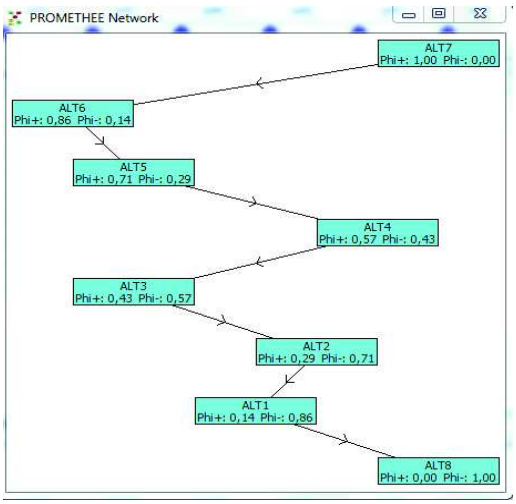
The results of the PROMETHEE I analysis are shown in Figures 4 and 5. Figure 4 shows the calculated preference flow of all alternatives, while Figure 5 gives the PROMETHEE network for all alternatives. It is easy to see that ALT7: Foreign Investment is the best and that ALT8: Public Investment is the worst.

Figure 4: Preference Flow

Preference Flows

	Phi+	Phi-	Phi
ALT1	0,1429	0,8571	-0,7143
ALT2	0,2857	0,7143	-0,4286
ALT3	0,4286	0,5714	-0,1429
ALT4	0,5714	0,4286	0,1429
ALT5	0,7143	0,2857	0,4286
ALT6	0,8571	0,1429	0,7143
ALT7	1,0000	0,0000	1,0000
ALT8	0,0000	1,0000	-1,0000

Figure 5: PROMETHEE Network



CONCLUSIONS

This work aimed to analyze financial investments for banks or financial institutions using the Multi-Criteria Method PROMETHEE. It employs results obtains in a previous analysis conducted with the AHP method [7]. Our next objective is now to compare these two analyses.

One limitation of this work is that the preferences were evaluated by one individual whose expertise was based primarily on a literature review. Therefore these preferences, and the conclusions we drew from them, should be considered tentative. In order to validate these first steps, we intend to obtain real preferences from risk managers in real-world banking institutions.

Acknowledgement
The authors would like to thank the CIMI Excellence Laboratory, Toulouse, France, for inviting Marc Kilgour on a Scientific Expert position during the period May-June 2015.

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