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Support System Decision with Logic Eτ applied to Merger and Acquisition - M&A: a case study in the education industry

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Abstract: This paper presents algorithm developed for the analysis of acquisition of educational companies from Logic Eτ. The aim is to promote the debate about corporate valuation models And propose a new approach, based on technical-operational criteria, in order to assess the feasibility of acquiring assets. In addition to the theoretical approach, the algorithm is applied in five real cases in Brazil. The objective is to present an algorithm that generates more efficiency and supports the decision maker in acquisitions of Educational Assets in Brazil.

Keywords: M&A,Valuation,Logic Eτ.

1. INTRODUCTION

This work concerns the system to support decision paraconsistent annotated evidential logic Eτ, for the acquisition of companies.A practical application was sought in the education sector, since the Brazilian educational market became very attractive and profitable for national and international groups.

Deciding on buying or selling an educational services company, like any other company, requires a lot of accuracy on the part of the decision maker.However, often the opinions of its analysts are contradictory and generate more uncertainty on the part of those who decide.

Analysts use a variety of tools to evaluate companies.Complex models of macroeconomic projections and advanced calculations, often generating inefficiencies, wastage, waste of time and distorted acquisitions for the business.

Developing an algorithm that provides efficiency is the main objective of this research, since this method allows to deal with contradictory data and has many advantages, such as: reliability, reliability, precision and versatility.

2. STATE OF ART

Several sources were consulted for the development of this research and it is divided in three great subjects namely: evaluation of companies; Education market in Brazil; Logic and E□

2.1 Valuation

Valuation is the English term for "business valuation" and is the heart of finance, because understanding what determines the value of a firm is a major challenge, given that the market is inefficient, and managers make mistakes in the valuation of companies [1].

[2] Affirm that Valuation requires deep knowledge of the analyzed company, observing peculiarities, among which: opportunities, threats, strengths and weaknesses. Being important to know also the market in which it is inserted.

[3] shows that valuation can be calculated directly, taking into account the market average, like the real world of ordinary people. For example, when buying a car or a house, the price to be paid is compared to the average value of similar on the market.

2.2 Education market in Brazil

In Brazil, teaching through private companies is free, provided there is authorization of operation by the public power.[4] in its operational structure defines the type of institutions of higher education regarding their academic organization at the University, University Center and Colleges.

According to [4] Universities are multidisciplinary institutions that enjoy autonomy, can create, extend and extinguish courses and number of vacancies, should also invest in master's and doctoral programs. University Centers are pluricurricular institutions that enjoy autonomy, can create, expand and extinguish

courses and number of vacancies, focusing on quality teaching and master's programs.Colleges do not enjoy autonomy, depending on the prior authorization of the Executive Branch to create, expand and extinguish courses and vacancies.

Education in Brazil is considered a public good because of the benefits it generates for every society in such a way that there is strict quality control.Created by [5], theNational System of Higher Education Assessment (Sinaes)consists of three main components: the evaluation of institutions, courses and student performance. The Sinaesestablished an indicator called General Index of Courses (IGC) as quality beacon, where the score ranges from 1 to 5, the higher the quality the higher the assigned note.Recidivist notes equal to or lower than 2 may close the institution.

Market leaders in 2016, listed on an exchange of values Brazil (BOVESPA), announced merger (Kroton) and (Estacio), through relevant fact published in the Brazilian press [6], thus resulting in a company with more than 1.5 Million students and more than R $ 16 billion in market value.This force has driven foreign investors - Actis (British), Advent (USA), Devry (USA), Laureate (USA), Blackstone (USA), Carlyle Group (USA) and Appolo (USA) to buy smaller Assets.

According to [7] 14% of Brazilian adults came to higher education, while the OECD average is 35%.Brazil has 8,027,297 students enrolled in higher education, and 6,075,152 are in private institutions . [8]Still, according to [8] are 2,364 higher education institutions, of which 2,069 are private.More than 60% of private institutions have less than 3,000 students and many are in cities with less than 50,000 inhabitants and are faced with a series of difficulties resulting from competition and the dynamics of government quality standards.

2.3 Logic Eτ

The annotated paraconsistent logic involves many aspects of *fuzzy logic*.This can be seen from various angles . [9]In the logical ANDT is associated with each proposition p in the common sense, comprised of a pair annotation constant(μ; λ),representing as follows: p(μ, λ),μandλvaries in real - closed interval [0,1].Therefore, the pair(μ, λ)belong to the Cartesian product [0,1] x [0,1].Intuitively,μis the degree of favorable evidence as P, andΛ,the degree of contrary evidence expressed as p.

The MAX operator lattice [0,1] x [0,1], associated with logic andτ, it is to be applied to a group of n notes (n≥1).It acts to maximize the degree of certainty (G_{cert} =μ-λ) this group of notes by selecting the best evidence favorable (higherμvalue) and the worst contrary evidence (lowerΛ), there being applied in situations where two or more items considered are not all determinants, just one of them has favorable condition to be considered satisfactory. [10]It is defined as follows: MAX $\{\mu_{1;1}\lambda),(\mu_{2,}\lambda_{2),}$ ... $(\mu_{n,}\lambda_{n)}\}$ = (max $\{\mu_{1,}\mu_{2,}$ ...,$\mu_{n},$ min $\{\lambda_{1,}\lambda_{2,}$ ..$\lambda_{n}\}).$

The MIN operator lattice [0,1] x [0,1], associated with logic andτ, it is to be applied to a group of n notes (n≥1).It acts to minimize the degree of certainty (G_{cert} =μ-λ) this group of notes by selecting the worst evidence favorable (lowest value ofμ) and the best evidence against (higher value ofλ) is applied in situations wherein the two or more items are all considered determinants, being essential that all exhibit favorable to consider the result satisfactory analysis [10].It is defined as follows: min $\{\mu_{1;1}\lambda),(\mu_{2,}\lambda_{2),}$ ... $(\mu_{n,}\lambda_{n)}\}$ = (min $\{\mu_{1,}\mu_{2,}$ ...,$\mu_{n),}$ max $\{\lambda_{1,}\lambda_{2,}$ ..$\lambda_{n}\}).$

In the final result, after applying the rules of maximization and minimization, it adopts as limits of truth and falsity as level of demand.In this way, there is evidence favorable or contrary to the feasibility of acquiring the asset, if there is a degree of certainty in a module equal to or greater than 0.6.Briefly: $G_{cert}\geq 0.6\rightarrow$Truth (V), ie, the acquisition of the asset is VIABLE;$G_{cert}\leq -0.6\rightarrow$Falsehood (F), ie, the acquisition of the asset is not feasible;$-0.6 < G_{cert} < 0.6\rightarrow$Confused (T), ie, DOUBT, should be the most relevant information.

3. METHODOLOGY

The objective this work was develop an expert system to support the decision to acquire assets, using paraconsistent logic annotated evidential Eτ. Decision support system is inserted in the universe of operational research, which has presented itself as something broad and complex.This work tries to give another scientific contribution in this field, developing this study based on paraconsistent annotated evidential logic that is alternative to the classic one. The problem presented is the acquisition of an Asset in a given region generates contradictory opinions and how to deal with it? The data collectwasdone through specialist (S) systems, with six volunteers divided into three groups, namely:- Group A: two proprietary experts from the University;- Group B: two experts in *Valuation andM&A* for education;and- Group C: two specialists in educational management.

These experts have raised and assessed the factors that influence the decision to purchase assets and pointed their initial evidence to understand the process, after this first collection *brainstorming* sessions were conducted for identification and discussion of factors.After the understanding that the factors are equal, the

construction of the logical proposition was proceeded.For each of these factors were established three scenarios C_j (C_1 to $C_{3)}$, as shown below:

Table 1: Expert-definedfactors

Factors	Theme	Section	Proposition
I	Inhabitants (I)	C 1	I> 50,000
		C 2	3 0.000≤I≤50.000
		C 3	I <30,000
NS	Number of Students (NS)	C 1	NS> 1,000
		C 2	5 00≤NS≤1.000
		C 3	NS <500
AA	Academic-Administrative (AA)	C 1	University
		C 2	Centre Universit
		C 3	College
GCI	General Course Index (GCI)	C 1	GCI> 2
		C 2	GCI = 2
		C 3	GCI <2
V	Valuation (V)	C 1	V <meanindustry
		C 2	V = meanindustry
		C 3	V>meanindustry

They were conducted two (02) *Delphi* rounds sought to identify relevant issues on asset acquisition of the higher education sector.The consultation was conducted by the form via *e-mail* - in two rounds.The biggest difference between them is that in the second round the outcome of the responses from each of the first round was reported, giving the respondent an opportunity to review their previous evidence if he so wished.

3.1 Search field

- The data on the three Assets sold were collected in a publication of relevant facts and through access to the website of the Ministry of Education (MEC) and the Brazilian Institute of Geography and Statistics (IBGE);

- The data on the two Assets that are for sale were collected through access to the website of the Ministry of Education - MEC, Brazilian Institute of Geography and Statistics - IBGE and telephone interview with the owners.

4. APPLICATION

Regarding the factors, one must reason that they are independent of each other.Therefore, it tried to assign degrees of favorable evidence **(μ)** and contrary evidence **(λ)** according to the experts, as follows.

Table2. Expert EvidenceDatabase

Factors	Section	AGroup				B Group				C Group			
		S_1		S_2		S_3		S_4		S_5		S_6	
		μ	λ	μ	λ	μ	λ	μ	λ	μ	λ	μ	λ
I	C 1	1.0	0.0	0.0	1.0	0.8	0.1	0.9	0.1	1.0	0.1	1.0	0.1
	C 2	0.5	0.5	0.5	0.4	0.4	0.6	0.6	0.3	0.3	0.3	0.2	0.2
	C 3	0.7	0.1	0.7	0.2	0.0	1.0	0.2	0.8	0.8	0.3	0.7	0.2
NS	C 1	0.8	0.1	0.9	0.1	1.0	0.0	0.9	0.1	1.0	0.1	1.0	0.1
	C 2	0.1	0.6	0.3	0.9	0.9	0.3	0.8	0.2	1.0	0.0	1.0	0.2
	C 3	0.7	0.1	0.7	0.2	0.0	1.0	0.2	0.8	0.8	0.3	0.7	0.2
AA	C 1	1.0	0.1	1.0	0.1	1.0	0.0	0.9	0.1	0.8	0.1	0.9	0.1
	C 2	1.0	0.1	1.0	0.1	1.0	0.0	0.9	0.1	0.8	0.1	0.9	0.1
	C 3	0, 8	0.1	0.7	0.2	0.0	1.0	0.8	0.2	0.8	0.3	0.7	0.2
GCI	C 1	0.8	0, 4	0.7	0.2	0, 7	0.1	0.8	0.3	0.8	0.5	0.5	0.2
	C 2	0.5	0.5	0.6	0.4	0.4	0.6	0.6	0.3	0.3	0.3	0.2	0.2

	C 3	0.7	0.1	0.7	0.2	0.0	1.0	0.2	0.8	0.8	0.3	0.7	0.2
V	C 1	1.0	0.1	1.0	0.1	1.0	0.0	0.9	0.1	0.8	0.1	0.9	0.1
	C 2	1.0	0.1	1.0	0.1	1.0	0.0	0.9	0.1	0.8	0.1	0.9	0.1
	C 3	0.7	0.1	0.7	0.2	0.0	1.0	0.2	0.8	0.8	0.3	0.7	0.2

With the database of the evidence of the experts (Table 1), one can observe some contradictions, for example, factor I, C1 section group A is contradiction between the two specialists, wherein S_1 hasμequal to 1, 0 while S_2 hasμequal to 0.0, but in the end it is possible to extract the evidence of the experts on the active acquisition viability of the higher education sector.They are shown in table 2 using the MAX and MIN rules.

Table 3: Degrees of evidence resulting from the application of MAX and MIN rules

Factor	Section	A group		B Group		C Group		BetweenGroups		Conclusions	
		μ_{max}	λ_{min}	μ_{max}	λ_{min}	μ_{max}	λ_{min}	μ_{min}	λ_{max}	G_{cert}	Decision
I	C 1	1.0	0.0	0.9	0.1	1.0	0.1	0.9	0.1	0.8	Viable
	C 2	0.5	0.4	0.6	0.3	0.3	0.2	0.3	0.4	-0.1	Doubt
	C 3	0.7	0.1	0.2	0.8	0.8	0.2	0.2	0.8	-0.6	not feasible
NS	C 1	0.9	0.1	1.0	0.0	1.0	0.1	0.9	0.1	0.8	Viable
	C 2	0 3	0, 6	0.9	0.2	1.0	0.0	0.3	0.6	-0.3	Doubt
	C 3	0.7	0.1	0.2	0.8	0.8	0.2	0.2	0.8	-0.6	not feasible
AA	C 1	1.0	0.1	1.0	0.0	0.9	0.1	0.9	0.1	0.8	Viable
	C 2	1.0	0.1	1.0	0.0	0.9	0.1	0.9	0.1	0.8	Viable
	C 3	0.8	0.1	0.8	0.2	0.8	0.2	0.8	0.2	0.6	Viable
GCI	C 1	0.8	0.2	0.8	0.1	0.8	0.2	0.8	0.2	0.6	Viable
	C 2	0.5	0.4	0.6	0.3	0.3	0.2	0.3	0.4	-0.1	Doubt
	C 3	0.7	0.1	0.2	0.8	0.8	0.2	0.2	0.8	-0.6	not feasible
V	C 1	1.0	0.1	1.0	0.0	0.9	0.1	0.9	0.1	0.8	Viable
	C 2	1.0	0.1	1.0	0.0	0.9	0.1	0.9	0.1	0.8	Viable
	C 3	0.7	0.1	0.2	0.8	0.8	0.2	0.2	0.8	-0.6	not feasible

4.1 Field Search

The next step was to do a field survey and evaluate five Assets in different cities to see which section each of the factors lies in.The result of this research took into account Acquired assets that were communicated through a relevant fact in the Brazilian press and random survey of two Assets in small cities in the State of São Paulo, whose owners indicated a sales interest.

FNC – Faculdade Nossa Cidade, an institution of higher education, installed in the municipality of Carapicuíba in the State of São Paulo, has 8,700 students.It was acquired in 2011 by the company Estacio Participacoes SA for R $ 90,000,000.00, or multiple of R $ 10,344.83 per student [11].General Course Index (IGC) equal to 3 [12].Carapicuibais amunicipality of the Greater São Paulo, in thestateofSão Paulo, inBraziland has 392,294 inhabitants . [7] As shown in the table below, all factors are in line with the evidence of the specialists, obtaining a viable decision to acquire the Asset under analysis, whose acquisition occurred.

Table4: FNCAsset

Factor	I	NS	AA	GCI	V
Section	C1	C1	C3	C1	C2
Decision	Viable	Viable	Viable	Viable	Viable

UnG - University of Guarulhos, an institution of higher education, installed in the city of Guarulhos in the State of São Paulo has 18,300 students.It was acquired in 2014 by the company Ser Educacional SA for R $ 199,100,000.00, ie multiple of R $ 10,879.78 per student [13].General Course Index (IGC) equal to 3 [12].Guarulhosis amunicipalityof theGreater São Paulo, in thestateofSão Paulo, inBraziland has 1,324,781 inhabitants . [7]As shown in the table below, all factors are in line with the evidence of the specialists, obtaining a viable decision to acquire the Asset under analysis, whose acquisition occurred.

Table5: UnGAsset

Factor	I	NS	AA	GCI	V
Section	C1	C1	C1	C1	C2
Decision	Viable	Viable	Viable	Viable	Viable

CEUNSP - University Center of Nossa Senhora do Patrocínio, institution of higher education, installed in the municipality of Itu in the State of São Paulo has 9,523 students.It was acquired in 2015 by theeducation group Southern Cross, which has the British fund Actis as a partner in the amount of R $ 100,000,000.00, ie multiple of R $ 10,500.00 per student [14].General Course Index (IGC) equal to 3 [12].Ituis amunicipality of the interior of thestateofSão Paulo, inBraziland has 154,147 inhabitants . [15]As shown in the table below, all factors are in line with the evidence of the specialists, obtaining a viable decision to acquire the Asset under analysis, whose acquisition occurred.

Table6: CEUNSPAsset

Factor	I	NS	AA	GCI	V
Section	C1	C1	C2	C1	C2
Decision	Viable	Viable	Viable	Viable	Viable

In the tables below, for ethical reasons, the names of institutions and cities are omitted, there are two Assets for sale installed in the municipalities X and Y in the State of São Paulo, with 454 and 1,068 students respectively, whose owners want to sell them.The owner of Active X only agrees to sell by a multiple above the market average, claiming to have bought that way, whereas for Asset Y it accepts multiple equal to the average.The PMI Active X and Y are equal to 1 and 3, respectively [12].The municipalities of the two assetshave 22,342 and 51,837 inhabitants, respectively [15].

Table7: XAsset

Factor	I	NS	AA	GCI	V
Section	C3	C3	C3	C1	C3
Decision	not feasible	not feasible	Viable	not feasible	not feasible

Table8: YAsset

Factor	H	THE	AA	GO	V
Section	C1	C1	C3	C1	C2
Decision	Viable	Viable	Viable	Viable	Viable

As seen in the tables above for Asset X, the fact that it is college generates interest and viability, however the size of the city's population, number of students, IGC and Valuation are not feasible.Whereas for the Y Asset the viability for acquisition is full.

After the field research, it is evident that each of the chosen experts used their knowledge, experiences, sensitivity, intuition, logical reasoning and analytical to verify evidence regarding the acquisition of educational services assets.

5. CONCLUSION

The acquisition of an Asset generates a series of opinions for and against, as could be observed in the database with the evidences of the experts.

The objective of this research was reached in full, because the algorithm developed can treat these contradictions, present logical results and serve as a decision support system, ratifying the initial hypothesis of this research.

The Brazilian educational market is broad, as presented in a bibliographic review, and provided field research with five real examples of Assets, successfully testing the developed algorithm.

Anyway, one of the advantages to using logic andτin this algorithm is its great versatility.You can increase accuracy and reliability in a number of ways.The way of example and future work, it is suggested to develop *software*, fix more factors, increase the number of specialists and increase the level of requirement of certainty.

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