Available online at www.sciencedirect.com

ScienceDirect

Procedia Economics and Finance 20 (2015) 510 – 517

Procedia Economics and Finance

www.elsevier.com/locate/procedia

7th International Conference on Globalization and Higher Education in Economics and Business Administration, GEBA 2013

Experiments and results by modeling the financial domain with UML

Vasile-Daniel Pavaloaia[a], Catalin Strimbei[a] *

[a] "Alexandru Ioan Cuza" University of Iasi, Carol I nr.22 Blv., Iasi, 700505, Romania

Abstract

The current research illustrates a framework for modeling the bankruptcy prediction models using the Unified Modeling Language. The developed framework uses the Anghel bankruptcy prediction model which is ranked by the local specialists as one of the most representative and actual autochthonous model. Also, our decision regarding the modeling of Anghel bankruptcy prediction function was based on the high accuracy rate of the model which is higher that 95%. Thus, through the UML modeling of the Anghel function it was intended to highlight the extent to which current economic transactions, carried out within the company (sales, purchasing, commissioning), submit through accounting operations (which supplies the balance of accounts) items in the annual financial statements information that determines the final score of Anghel function. Due to such application, any company could be able to find out at any moment the Anghel score value and hence the company's financial status (which can be either financial stability or bankruptcy risk). Owning such information could be vital for the company because, in the case of financial instability warning, the top management will have a sufficient margin of time to bring the activity to a healthy state and thus to prevent the bankruptcy settlement. Furthermore, the current UML developed model can be acquired by a add-on computer application and integrated into an ERP system within a Business Intelligence Component or a Scorecard component/module. Through such integration, the application will benefit from the computerization of other ERP modules from which will be able to retrieve information regarding the account balances. Such information is necessary to determine the cumulative, multi-level hierarchical Z-score value function as presented in our detailed UML model.

Peer-review under responsibility of the Faculty of Economics and Business Administration, Alexandru Ioan Cuza University of Iasi.

Keywords: UML, bankruptcy prediction models, Anghel model, Z-score computer modelling

*Corresponding author
E-mail addresses: linus@uaic.ro

Peer-review under responsibility of the Faculty of Economics and Business Administration, Alexandru Ioan Cuza University of Iasi.
doi:10.1016/S2212-5671(15)00103-3

1. Introduction

More often, the accounting and financial statements analysis is aimed to identify the financial instable areas which require detailed investigations. An example of such action is the bankruptcy risk analysis which implies the use of one or more bankruptcy prediction models. Such models are based on statistical methods meant to achieve an optimal and relevant combination of economic and financial ratios [Subramanyam, 2012]. The resulting Z-score posses a certain prediction ability which is expressed by the model's accuracy rate that can be used by the management in order to establish a set of actions meant to overcome enterprise's negative effects. Worldwide, the most widely used bankruptcy prediction models are: Altman model(1968 and 1983), Springate model(1978), Conan and Holder model, CA Score model (1987), Fulmer model (1984), Yves Collonques (1) and Yves Collonques (2) models. The bankruptcy prediction models incorporate the most representative financial ratios such as asset's profitableness, indebts rate, solvency rate and others [Revsine, 2008],[Vâlceanu, 2004],[Petrescu, 2006]. The Romanian specialized literature presents several bankruptcy prediction models among which, the most known are: Anghel model, Băileşteanu model, Mânecuţă and Nicolae model [Pavaloaia, 2008].

2. UML elements required by enterprise process modeling

UML is the visual, specification, development and documentation language. Among its most important particularities and advantages, we enlist: complex models development through a rigorous standard modeling language – open standard(1); models the entire lifecycle of software development(2); it doesn't automatically guarantee the success of the developed applications but improves many elements related to the development process(3); covers a wide range of application types(4); is based on the extensive experience of those who have developed it (5); is used by many CASE products (6).

3. Overview of the bankruptcy prediction modeled through UML

In this paragraph we aim to highlight the process modeling with UML, the score function for Anghel bankruptcy prediction model. In this paragraph we aim to highlight the process modeling, with UML, namely the score function modeling for Anghel bankruptcy prediction model. From the multitude of bankruptcy prediction models existing in the Romanian literature, have chosen the Anghel model since it is considered to be the most representative and recent model. The model is applicable across the Romanian economy and is developed on a sample of 276 enterprises in 12 sectors of the national economy. Initially in the Z score function were included 20 financial ratios, and after the selection phase were retained only the most significant ones, namely[Anghel, 2002]: revenue profitableness ratio(X1), coverage ratio of debt cash flow (X2), leverage ratio(X3), duration of bonds payment (X4). The Z score function is presented in Fig.1 and the results interpretation is: $Z < 0,0$ high bankruptcy probability risk, $Z > 2,05$ displays a favorable financial situation [Buglea, 2005]. The ratios X1 to X4 may be determined through the use of the formulas outlined in the relations 6.50 to 6.53 [Anghel, 2002]:

X1= Net profit/Total income 6.50
X2 = Cash flow/Assets 6.51
X3 = Debts/Assets 6.52
X4 = Bonds/Turnover 6.53

Each of the elements presented in relations 6.50-6.53 turn into ratios whose determination is based on other elements according to a certain algorithm. Depending on the ratio particularities, decomposition can be repeated on multiple levels and up to the elements of the annual financial statements (Balance sheet, Profit and loss statement, Cash flow statements) in which it will refer the row number and account/accounts whose balances rise, in fact, the Z score value.

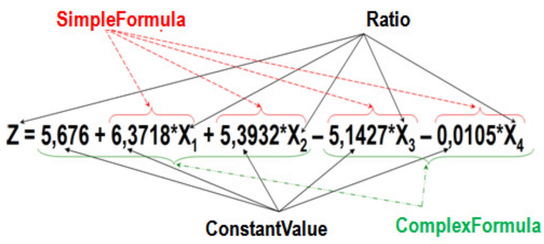

Fig. 1 Z-score and UML classes that correspond to the model's elements

Therefore, by modeling the Z score function in UML, we have aimed to highlight the extent to which current economic transactions within an enterprise (selling, purchasing, leasing out, etc...) convey to accounting entries in annual financial statements, via accounting operations (which debit accounts), information that determines the value of the Z function. Through such a computerized solution, the enterprise could be aware at any moment, either before or after the synthesis documents are drawn, the value of the Z score function and implicitly, it could evaluate its financial position (financial stability or bankruptcy risk). Possession of such information could be vital for an enterprise because in case of financial instability, its management team would have a time margin that would be sufficient enough to restore its activity to proper parameters and thus prevent bankruptcy.

4. The use of UML for modeling the Anghel score

In order to use UML for Anghel Z-score modeling we employed a set of specific diagrams (activity, class and object diagrams). To illustrate the logic approach of the model we developed, we'll only display some of the components, due to the space constraints.

In general, the class diagram aims to describe the static structure of information or knowledge related to the field of application. This type of diagram display the logical models that capture the basic structure of the system [Strimbei, 2003], and its core elements are class and association. Classes can represent groups of objects of the same type that belong to the subject matter domain that is to be modeled. Class consists of specific compartments, for the class name, class and attributes specification, and the operations that can be attached to the class objects. The association defines relations between classes and is somewhat similar to an attribute because it is used to define a property that belongs to a class object [Andone, 2004],[Scmuller, 1999]. Generalization allows building class hierarchies in which subclasses inherit the characteristics (attributes, operations and associations) of the higher level classes in the superior hierarchy. In our UML model, it is also used realization and association relations. Realization is a semantic relationship between two classes in which one has stated a requirement to be carried out by the second [Booch, 1999].

Consequently, in Fig.2 we used the class diagram to generic model the formulas typology for the model developed by Anghel. In this context, the realization is used to specify the relationship between the Operand interface and the classes whose instances can be built up in order to form the expressions required by ratios determination. Thus, AbstractFormula class is in an association relationship with subclasses SimpleFormula and ComplexFormula, the latter being in an association relationship AbstractFormula class whose cardinality is 1-to-many. The Operand is represented as an object interface for the four types of classes and is involved in the description of a particular formula. All the above described elements will be part of the Z function formula, the intermediate indicators X1-X4 and further, of all the other elements found at different hierarchy level. This mechanism allows composition of complex formulas from simpler formulas that are broken down on several levels. A calculation expression (formula) is described through a set of operands (Operand instances) "related" through an operator.

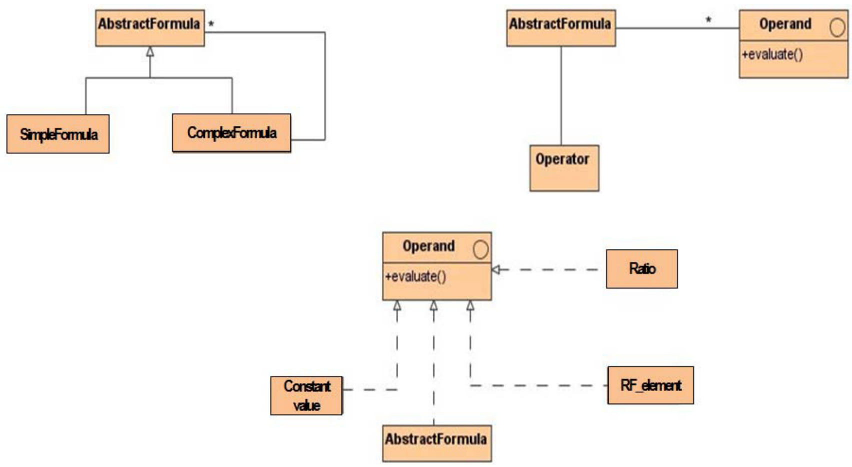

Fig.2 Class diagram that belong to AbstractFormula class

Based on the framework created by the class diagram shown in Fig.2, the model for the Z score function was developed. In Fig.1 is presented the Z score function and class names used to transpose the UML elements for formula. Fig.3 displays the object diagram who aims to model the Z function presented in Fig.1. Since in the composition of function Z enters a wide range of elements (constants, indicators, formulas and operators) for the purpose of elements and their related relationships modeling were created two branches: first for the elements that are added and the second for those who are substracted from the model. Basically, the formula is modeled through the class instances created in the diagrams illustrated in Fig.1-3 by binding the ratio (X1) to the ConstantValue (6.3718) through an instance of the Operand class (multiplication) for the purpose of f1 formula representation. Finally, all instances of the class SimpleFormula (f11, f12) are related through an Operand class (add or subtract) to the instance of ComplexFormula class. This is the general relationship of the composition algorithm to calculate the Z score function.

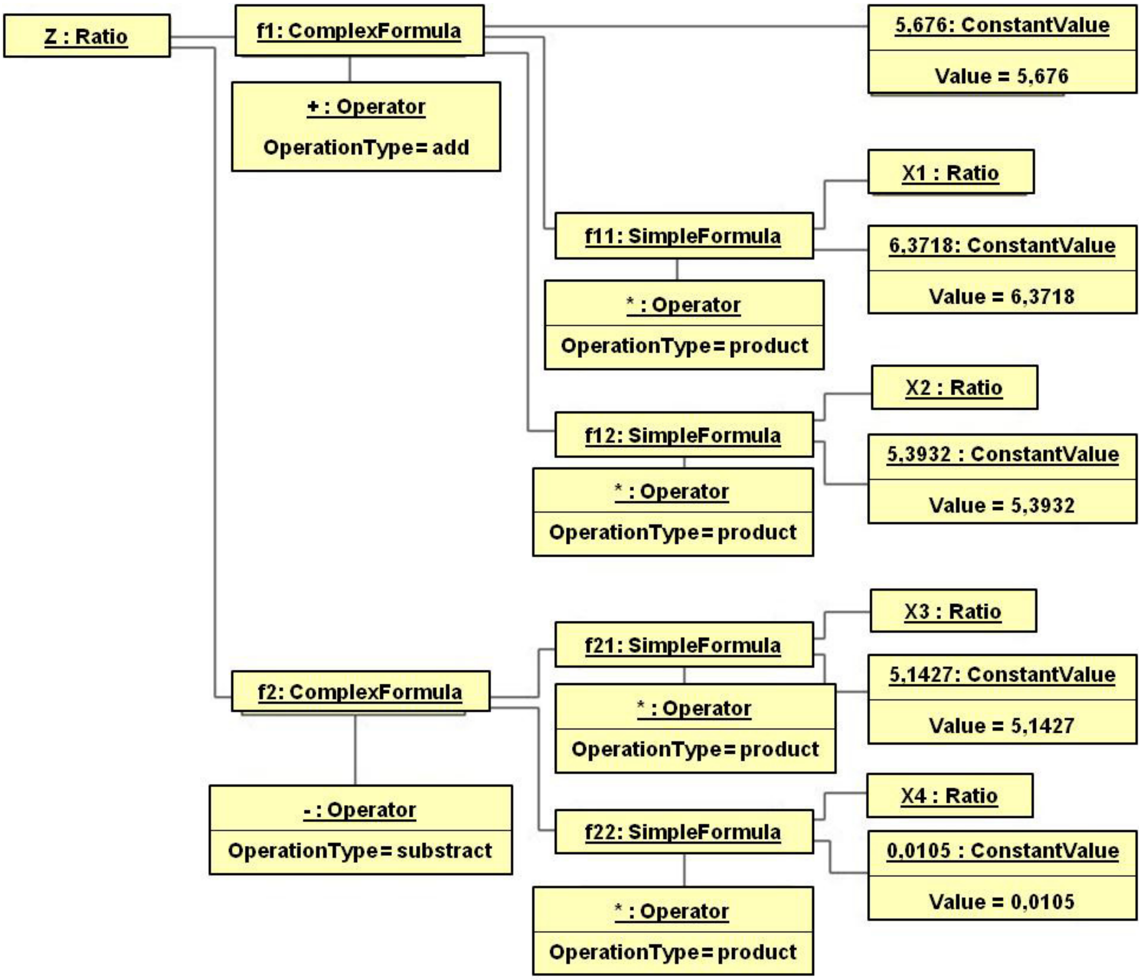

Fig.3 Object diagram that models the Z score function

On the next tier, each of the ratios (X1-X4) is decomposed (see Fig.4) in strict accordance with the formula presented in Fig.1 and explained on the relationships 6.50-6.53. Due to the large volume of information, the current paper does not include the diagrams that define all the ratios nor the diagrams/ hierarchical decomposition levels for the next hierarchical ratios. Those diagrams show the ratios components related to the model, including the financial statement called, the number line, the accounts and their balance, all implemented as instances.

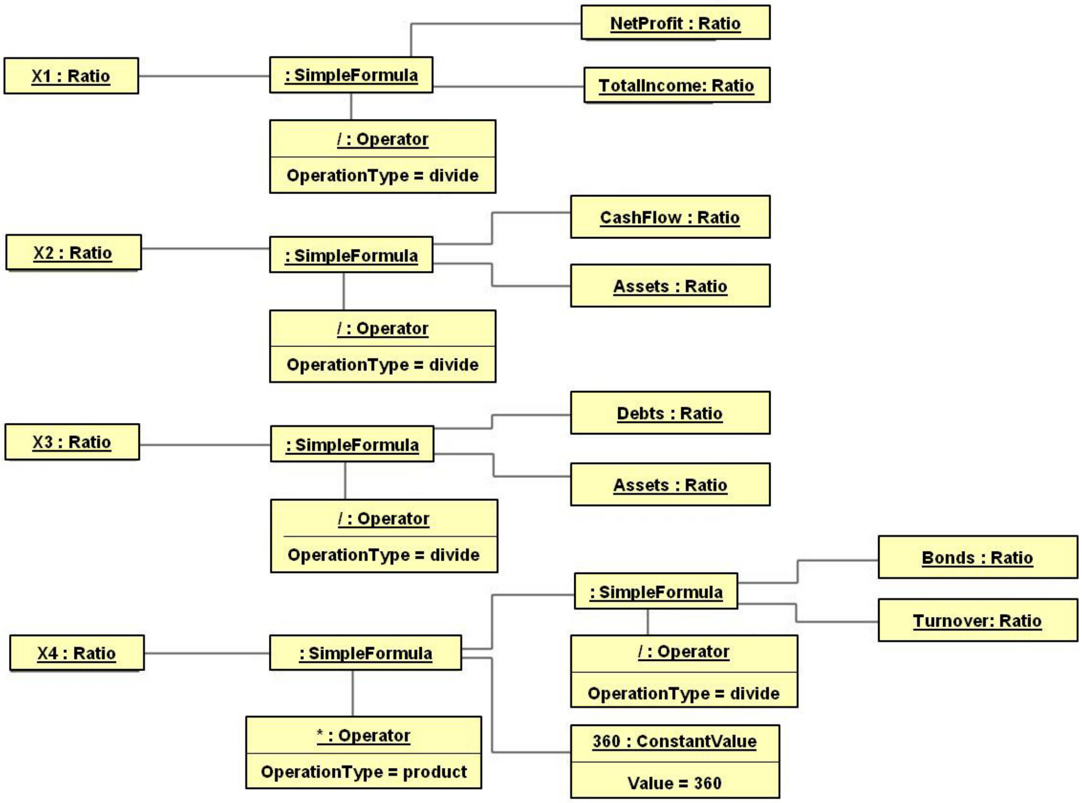

Fig.4 Object diagram that model the X1-X4 ratios

5. Model integration possibilities under the category of enterprise information systems

Our vision regarding the functionality of an application developed in UML based on our model is summarized in Fig. 4. Thus, the activity diagram captures three distinct subsystems that communicate via asynchronous signals. In order to present the communication manner between the systems, there were used signals type objects that are intended to initiate the asynchronous communication from the sales management system to the accounting and financial operational system till the accounting and financial decision system [Andone, 2004].

Within the sales management system there is a series of activities taking place in parallel (ie: Product expedition, Fill in invoice, Post the invoice, Make the payment). For this reason, it was used fork and join type elements to suggest the flow of coordination of activities. The different degree of granularity in the three systems is justified by the intention to particularly highlight the decisional process that accompanies the Z score and the interpretation of its value. Thus, in the corresponding sector or partition that belongs to the accounting and financial decision system, the variant Z score interpretations are represented based on the object decision (graphically represented through a diamond) in three alternative directions, represented by arrows. When the value of Z score is less than zero, enterprise activity is low and exposed to the risk of bankruptcy. This situation calls for enterprise management important decisions to be taken, in the direction of rescue the enterprise from an imminent bankruptcy situation. The favorable situation, namely the financial stability occurs when the value of the Z score function exceeds the value 2.05. Besides these two cases, another one may occur: when there is a situation corresponding to an error in calculation (of ratios or its elements). In this case, the value Z score function falls in the range 0 to 2.05. In the event of this case there will be recalculated the financial ratios underlying relationship that determines the Z score function. Therefore, to avoid anomalies in the ratios determination stage, there should be checked whether the numerical values are expressed unitary.

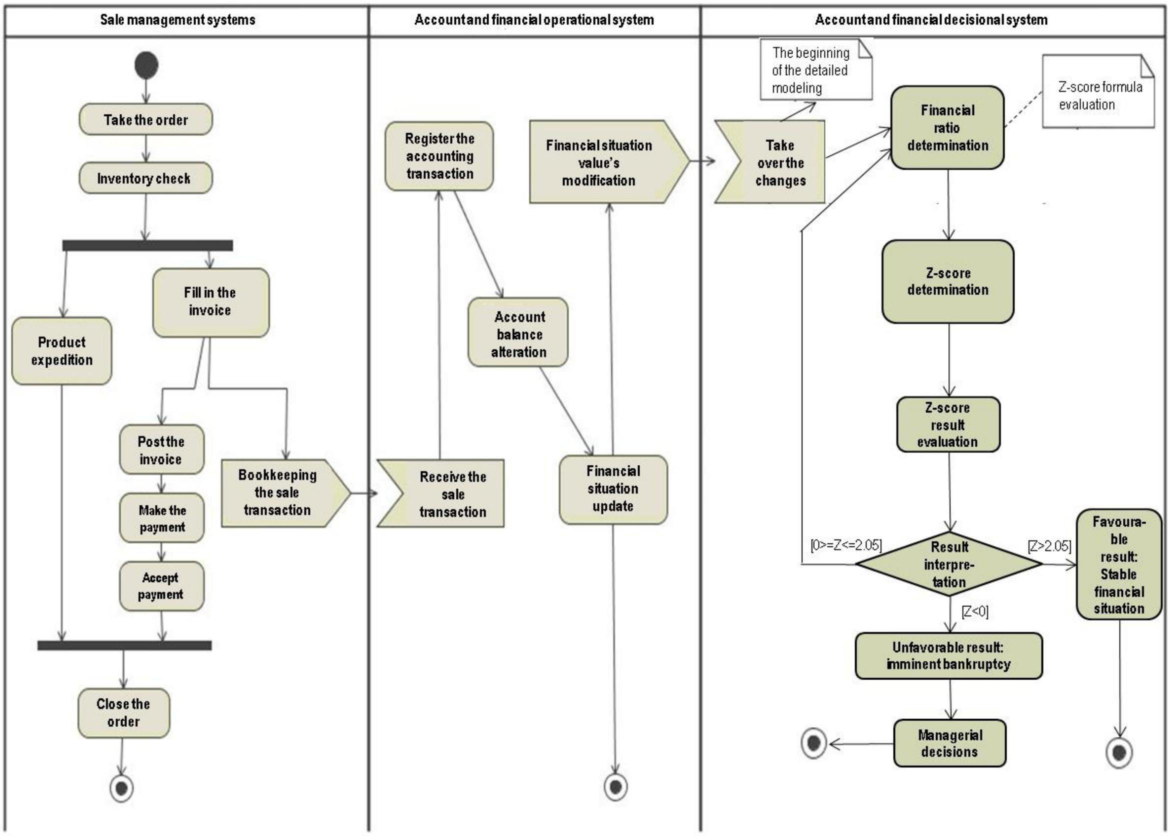

Fig.5 Activity diagram

6. Conclusions and further research paths

UML is a very general modeling language that can be extended on specific domains, including the economic and financial analysis, thus simplifying the language generic structure. The UML language allows a great variety of problem modeling, including those that belong to the economic and financial field. Due to the above reasons, within the current research we have decided to illustrate the UML modeling of the Anghel bankruptcy prediction model. We have chosen Anghel's model for two reasons: (1) is the most recent Romanian model (2002) and (2) is considered by the specialists as the most representative one (having the highest prediction rate). The proposed model can be taken over within an Add-on application and be integrated within an ERP system, through a Business intelligence or ScoreCard component. Such integration would allow our application to beneficially exploit the integration advantages offered by the ERP systems which mainly consists in taking the information about account balances from the financial statements. This information is required as it determines in cascade on multi-level hierarchies the value for the Z-score function of Anghel bankruptcy prediction model.

To sum up, the current research presents a manner of modeling such activities as evaluation and representation of a set of financial ratios which ultimately leads to the value determination of a bankruptcy prediction function. In this respect, the proposed model illustrates an original way of solving the decision problems that occur in the accounting information system of a company. This model can then be acquired by an add-on computer application and integrated into an ERP system. Through such integration, our application will benefit from computerization of other modules / system in which you retrieve information about account balances. This information is necessary to determine the cascade multi-level hierarchical Z-score value function

As future research direction the author's intention is to study the possibilities of design and development of an application that would fully computerize Anghel bankruptcy prediction model, starting from the current proposed model developed by using UML specifications.

References

Altman, E., Predicting Financial Distress of Companies: Revisiting the Z-score and ZETA® Models, 2000.
Anghel, I., Falimentul. Radiografie şi predicţie, Ed. Economică, Bucureşti 2002.
Andone, I., XBRL – a new language for accounting and finance professionals, In Journal of Business Informatics nr. 2(30)/2004.
Booch, G., Rumbaugh, J., Jacobson, I., The UML Language User Guide, Addison Wesley, 1999.
Buglea, Al., Analiză financiară. Concepte şi studiu de caz, Editura Mirton, Timişoara, 2005.
Grama, A., Pavaloaia, V.D. Comparative Analysis using Bankruptcy Prediction Models. An online computer-based system, European Computer Conference'08, Organizator WSEAS, Malta, Septembrie 2008.
Petrescu, S., Analiză și diagnostic financiar-contabil, Ghid teoretico-aplicativ, Ed. C.E.C.C.A.R., București 2006.
Revsine, L., Collins, D., Johnson, B., Mittelstaedt, F., Financial Reporting and Analysis, 4th Edition, Prentice Hall 2008.
Scmuller, J., Teach yourself UML in 24 hours, SAMS Publishing, Macmillan Computer Publishing, USA 1999.
Strimbei, C., Utilitatea metodologiei UML în proiectarea bazelor de date, In Journal of Business Informatics nr.2(26)/2003.
Subramanyam, K., Wild, J., Financial statement analysis, 11th Edition, McGraw Hill, 2012.
Vâlceanu, G., Robu, V., Georgescu, N., Analiza economico-financiară, Ediția a IIa, Editura Economică, Bucureşti, 2005.