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APPLICATION OF SELECTED EARLY WARNING MODELS IN COMPANY BANKRUPTCY PREDICTION AS ILLUSTRATED BY QUMAK S.A. COMPANY

Introduction

One can never be sure in market economy whether company's business operations will be successful. The market decides which companies will continue their operations and which ones are going to fail. The phenomenon of bankruptcy of enterprises is a common natural regulator of market economy. Companies that are not sufficiently effective and competitive are eliminated from the market through selection. The process of bankruptcy clears the economic market from enterprises that are not able to face its demands¹.

The aim of the article is to present the effectiveness of selected early warning models of company's bankruptcy as illustrated by the QUMAK company.

1. Economic, legal and social aspects of company bankruptcy – general comments

The term *bankruptcy* appears in numerous areas of science and may be interpreted in various ways in relation to the context.

In the economic sense, bankruptcy is the financial state of a company that is insolvent or whose liabilities exceed the assets. Insolvency is a financial situation where company's assets are not sufficient to cover its liabilities, the company is in debts and stops paying its obligations. In short, bankruptcy is the inability to meet one's financial obligations. In the economic sense, bankruptcy is also defined as the state of a company which is incapable of carrying further independent operations on the economic market and being competitive without any external assistance².

¹ K. Bauer, *Zarządzanie informacjami w procesie upadłościowo-naprawczym przedsiębiorstw*, Wydawnictwo Uniwersytetu Jagiellońskiego, Kraków 2009, p. 7.

² B. Prusak, *Ekonomiczna analiza upadłości przedsiębiorstw – ujęcie międzynarodowe*, Warszawa 2011, p. 23.

In the legal sense, bankruptcy is an institution which plays a significant role in market economy as it stops a critical situation of an entity through excluding it from the economic environment. Bankruptcy, as an institution which ceases the accumulation of company liabilities, alleviates negative effects of insolvency and liquidates the assets of the debtor to meet outstanding financial obligations.

Bankruptcy is a legal situation of an entity, which is the result of court's order. The entity is deprived of the right to manage its assets which are split among creditors in the course of bankruptcy procedure. In the cases where the remaining assets are insufficient to cover the liabilities, the loss is spread proportionally among them³.

In the Polish legal system, company bankruptcy is regulated by the Bankruptcy and Reorganization Law of 28th February 2003. The Act governs⁴:

- rules for a collective pursuit by creditors' claims against insolvent debtors who are entrepreneurs,
- rules for pursuing claims against insolvent debtors who are natural persons that do not run business activities,
- the effects of declaring bankruptcy,
- rules for redemption of liabilities of the bankrupt who is a natural person

The Bankruptcy and Reorganization Law distinguishes three possible ways of action in the case of financial problems⁵:

- remedial proceedings,
- bankruptcy proceedings leading to the conclusion of an agreement,
- bankruptcy proceedings leading to the liquidation of assets.

It might seem that bankruptcy is a negative phenomenon; however this is not the case. The objective of bankruptcy and remedial regulations is to take care of public interest and to protect economic market participants against insolvent enterprises. Outstanding liabilities of bankrupt companies may worsen the financial situation of their creditors and that is why the monitoring of such companies is an important social aspect of bankruptcies. Monitoring is helpful in detecting companies that have problems and are at risk of bankruptcy⁶.

³ J. Bogdanienko, W. Piotrowski, *Zarządzanie. Tradycja i nowoczesność*, Polskie Wydawnictwo Ekonomiczne, Warszawa 2013, p. 89.

⁴ Art. 1.1, Act of 28th February 2003, Bankruptcy and Reorganization Law; Journal of Laws No.60, item 535, as amended

⁵ K. Bauer, *Zarządzanie informacjami...*, op. cit., p.23.

⁶ Z. Leszczyński, A. Skowronek-Mielczarek, *Analiza ekonomiczno-finansowa spółki*, Polskie Wydawnictwo Ekonomiczne, Warszawa 2004, p. 146.

At present, it is very important to implement early-warning systems to monitor company financial situation. Such discriminant models make it possible to predict risks. Thanks to the models, managers are informed that their company may enter into crisis or already is in it. They can react quicker to anomalies and consequently management changes are introduced more quickly.

2. General characteristics of selected discriminant models with the consideration of Polish economy

Polish scholars became interested in the issue of company bankruptcies in mid-1990s, which is rather late in comparison to other countries where research on bankruptcy started already in 1940s. The models of M.Pogodzińska and S.Stojak as well as of E.Mączyńska are the first bankruptcy prediction models in Polish economy⁷.

E. Mączyńska's model is the adaptation of O.Jacobs function to the specifics of Polish economy. Although the model was developed in 1990s, its prediction values are still very high. According to Paweł Antonowicz⁸, Mączyńska's model is the third best valued model and is given by⁹:

$$Z_M = 1,5X_1 + 0,08X_2 + 10X_3 + 5X_4 + 0,3X_5 + 0,1X_6$$

where:

- $X_1 = \frac{\text{gross result+depreciation}}{\text{total liabilities}}$
- $X_2 = \frac{\text{balance sheet total}}{\text{total liabilities}}$
- $X_3 = \frac{\text{gross result}}{\text{balance sheet total}}$
- $X_4 = \frac{\text{gross result}}{\text{sales revenues}}$
- $X_5 = \frac{\text{value of inventory}}{\text{sales revenue}}$
- $X_6 = \frac{\text{sales revenue}}{\text{balance sheet total}}$

Interpretation principles of the results in E.Mączyńska's model are presented in Table 1.

⁷ J. Pocięcha, *Statystyczne metody prognozowania bankructwa w zmieniającej się koniunkturze gospodarczej*, Fundacja Uniwersytetu Ekonomicznego w Krakowie, Kraków 2014, p. 19.

⁸ P. Antonowicz, *Metody oceny i prognozowania kondycji ekonomiczno-finansowej przedsiębiorstw*, Ośrodek Doradztwa i Doskonalenia Kadr Sp. z o.o., Gdańsk 2007, pp. 176-199.

⁹ Ibidem, pp. 51-52.

Table 1. Bankruptcy risk classification for indicator Z_M

Value of indicator Z_M	Level of bankruptcy risk
$Z_M \leq 0$	The company is at risk of bankruptcy within one year
$0 < Z_M < 1$	The company is functioning poorly but is not at the risk of bankruptcy
$1 \leq Z_M \leq 2$	The company is functioning well
$Z_M > 2$	The company is functioning very well

Source: based on P. Antonowicz, *Metody oceny i prognozowania kondycji ekonomiczno-finansowej przedsiębiorstw*, Ośrodek Doradztwa i Doskonalenia Kard Sp. z o.o., Gdańsk 2007, p. 52.

When analysing the model, it is worth mentioning that there is no grey zone range, which means that there will be no cases when the value of the discriminant function does not state clearly whether the company is at risk or prosperous. In other words, every result of the function can be interpreted in line with table 1¹⁰.

The models that are ranked first and second on Paweł Antonowicz's list, i.e. models with the highest company bankruptcy prediction effectiveness were developed in the Institute of Economic Sciences of the Polish Academy of Sciences (PAS). The research was supervised by E. Mączyńska who was accompanied by M. Zawadzki, M. Żuchowski and J. Janek¹¹. Discriminant functions $Z_{7\text{INE PAN}}$ oraz $Z_{6\text{INE PAN}}$ were developed on the basis of the financial data from 1997-2002 for 80 enterprises that were listed on the Warsaw Stock Exchange. The enterprises under investigation included 40 entities that were considered bankrupt and 40 other that were prosperous. The bankrupt companies were classified through the assessment of their financial situation with the application of the index analysis. Companies were considered bankrupt when they had a negative equity, experienced a loss in subsequent years or became insolvent¹².

The research at the PAS Institute of Economic Sciences resulted in the development of seven discriminant functions that applied a varied number of indicators, ranging from 4 to 12. The two most effective bankruptcy prediction models are given by¹³:

¹⁰ P. Antonowicz, *Metody oceny i prognozowania...*, op. cit., p. 52.

¹¹ E. Mączyńska, M. Zawadzki, *Dyskryminacyjne modele predykcji upadłości przedsiębiorstw*, „Ekonomista” 2006, No 2, pp. 203-230.

¹² R. Balina, M. J. Bąk, *Analiza dyskryminacyjna jako metoda predykcji bankructwa przedsiębiorstw z uwzględnieniem aspektów branżowych*, Wydawnictwo Naukowe INTELLECT, Waleńców 2016, pp. 108-110.

¹³ P. Antonowicz, *Metody oceny i prognozowania...*, op. cit., pp. 41-43

$$Z7_{INE PAN} = 9.498 X_1 + 3.566X_2 + 2.903X_3 + 0.452X_4 - 1.498$$

and

$$Z6_{INE PAN} = 9.478 X_1 + 3.613X_2 + 3.246X_3 + 0.455X_4 + 0.802X_5 - 2.478$$

where:

- $X_1 = \frac{\text{operating result}}{\text{asset value}}$
- $X_2 = \frac{\text{Equity value}}{\text{Asset value}}$
- $X_3 = \frac{\text{Net financial result+Depreciatio}}{\text{Total liabilities}}$
- $X_4 = \frac{\text{Current assets}}{\text{Short-term liabilities}}$
- $X_5 = \frac{\text{Sales revenue}}{\text{Asset value}}$

The interpretation of the result is the same for the two above discriminant functions. Table 2 presents the interpretations of the results obtained for the above models.

Table 2. Bankruptcy classification for indicators $Z_{INE PAN}$

Value of indicators $Z_{INE PAN}$	Bankruptcy risk level
$Z_{INE PAN} \leq 0$	The company is at risk of bankruptcy within a year
$Z_{INE PAN} > 0$	The company is not at risk of bankruptcy

Source: based on P. Antonowicz. *Metody oceny i prognozowania kondycji ekonomiczno-finansowej przedsiębiorstw*, Ośrodek Doradztwa i Doskonalenia Kard Sp. z o.o., Gdańsk 2007, p. 42.

The fourth best valued model is the “Poznań” model which was developed by a team under the supervision of M.Hamrola with the participation of B.Czajka and M.Piechocki. The discriminant function was developed on the basis of the analysis of financial data from 100 Polish commercial companies. The data analysis of the companies comprised three stages. First, adequate time range as well as reliable financial data sources were selected in order to obtain a statistical sample. In stage two, the values of 31 indexes were calculated. Stage three consisted in the selection from 31 indexes of adequate explanatory variables which were applied in the discriminant function. In the selection of variables to the model, the authors rejected the ones

that were strongly correlated to one another. The discriminant function in the ‘Poznań’ model is given by¹⁴:

$$Z_{HCP} = 3.562X_1 + 1.588X_2 + 4.288X_3 + 6.719X_4 - 2.368$$

where:

- $X_1 = \frac{\text{Net financial result}}{\text{Balance sheet total}}$
- $X_2 = \frac{\text{Current assets} - \text{Inventory}}{\text{Short-term liabilities}}$
- $X_3 = \frac{\text{Fixed capital}}{\text{Balance sheet total}}$
- $X_4 = \frac{\text{Sales results}}{\text{Sales revenue}}$

The interpretation of the result of the obtained discriminant function is the same as the result interpretation in model $Z_{INE PAN}$. Zero is the limit point. A value less than 0 indicates that the company is at risk of bankruptcy, while values above zero indicate that the company is not at risk¹⁵.

3. Financial situation assessment of the QUMAK company with regard to bankruptcy risk on the basis of data from 2016-2017

The object of analysis was the Qumak company, a Polish IT company that deals with designing and implementing ICT solutions for the private and public sector¹⁶.

Firstly, the early-warning model of E. Mączyńska is presented. Discriminant function Z_M is a very good tool of monitoring company financial situation as the interpretation of the function value includes range (0,1) according to which the company is not functioning well but it is not at risk of bankruptcy, either. Thus, if the value of the function calculated for a given company is in this range, the managing staff should take new decisions to improve company's situation¹⁷.

Table 3 presents the calculated indexes that were applied in the Mączyńska model.

¹⁴ B. Prusak, *Nowoczesne metody prognozowania zagrożenia finansowego przedsiębiorstw*, Difin, Warszawa 2005, p.166.

¹⁵ R. Balina, M. J. Bąk, *Analiza dyskryminacyjna...*, op. cit. pp. 112-113.

¹⁶ <http://www.qumak.pl/o-firmie/kim-jestesmy> (accessed: 27.10.2019).

¹⁷ P. Antonowicz, *Metody oceny i prognozowania...*, op. cit., pp. 51-52.

Table 3. Values of indexes that were calculated for model Z_M

YEAR	Index X_n	Numerator (thousands PLN)	Denominator (thousands PLN)	Calculation result
2016	X_1	15 899	186 054	0.0855
	X_2	195 460	186 054	1.0506
	X_3	13 081	195 460	0.0669
	X_4	13 081	424 496	0.0325
	X_5	2 404	424 496	0.0057
	X_6	424 496	195 460	2.1718
2017	X_1	-21 370	145 315	-0.1471
	X_2	110 333	145 315	0.7593
	X_3	-23 960	110 333	-0.2172
	X_4	-23 960	258 506	-0.0927
	X_5	3 859	258 506	0.0149
	X_6	258 506	110 333	2.2330

Source: based on the financial report of the Qumak S.A. company for fiscal year completed on 31 December 2016 and for fiscal year completed on 31 December 2017.

The values of discriminant function Z_M for the data for 2016 and 2017 equal 1.2627 and -2.1506, respectively. According to the interpretation, value 1.2627 for 2016 means that the company is prosperous, while value -2.1506 indicates that the company was at risk of bankruptcy within one year. This may mean that the company was prosperous at the beginning of 2016 while at the end of the year crisis situations appeared, which is reflected by the disastrous results for 2017.

Analysis of company financial situation should not be completed after the use of one early-warning model. Every model has both advantages and disadvantages such as the stability of balance sheet data or the time that passed after the assessment of weights in the discriminant function¹⁸. That is why it is important to verify the results obtained by other early-warning models.

Table 4 present the calculated indexes that were applied in models $Z_{7\text{INE PAN}}$ and $Z_{6\text{INE PAN}}$.

The values of discriminant function $Z_{6\text{INE PAN}}$ for the data for 2016 and 2017 are -2.2704 and -8.5623, respectively.

The values of discriminant function $Z_{7\text{INE PAN}}$ for the data for 2016 and 2017 are -3.0665 and -9.2916, respectively.

¹⁸ T. Korol, *Systemy ostrzegania przedsiębiorstw przed ryzykiem upadłości*, Oficyna a Wolters Kluwer business, Warszawa 2010, pp. 126-127.

Table 4. Index values calculated for models Z₆INE PAN and Z₇INE PAN

Year	Index X _n	Nominator (thousands PLN)	Denominator (thousands PLN)	Calculation result
2016	X ₁	-31 636	195 460	-0.1619
	X ₂	9 406	195 460	0.0481
	X ₃	-40 163	186 054	-0.2159
	X ₄	160 340	170 726	0.9392
	X ₅	424 496	195 460	2.1718
2017	X ₁	-64 930	110 333	-0.5885
	X ₂	-34 982	110 333	-0.3171
	X ₃	-71 670	145 315	-0.4932
	X ₄	82 268	103 694	0.7934
	X ₅	258506	110 333	2.3430

Source: based on financial report of the Qumak company for fiscal year completed on 31 December 2016 and for fiscal year completed on 31 December 2017.

According to the interpretation of the data from table 2, the company is at the risk of bankruptcy within one year as the values of the calculated discriminant functions are significantly less than zero. Such results may indicate that the company is in crisis. It may soon apply for bankruptcy if the management does not implement a remedial strategy.

The fourth most effective early-warning model is the Poznań model. Table 5 presents the calculated indexes that were applied in this model.

Table 5. Values of indexes for model Z_{HCP}

Year	Index X _n	Nominator (thousands PLN)	Denominator (thousands PLN)	Calculation result
2016	X ₁	-42 981	195 460	-0.2199
	X ₂	157 936	170 726	0.9251
	X ₃	24 724	195 460	0.1265
	X ₄	13 081	424 496	0.0308
2017	X ₁	-74 260	110 333	-0.6731
	X ₂	78 409	103 694	0.7562
	X ₃	6 638	110 333	0.0602
	X ₄	-23 960	258 506	-0.0927

Source: based on financial report of the Qumak company for fiscal year completed on 31 December 2016 and for fiscal year completed on 31 December 2017.

The interpretation of the above model of M. Hamrold, B. Czajka and M. Piechocki is the same as the interpretation for model Z_{INE PAN}. The values of the discriminant function for 2016 and 2017 are -0.9494 and -3.8794, respectively. Such values indicate that the Qumak company is at risk of bankruptcy within a year.

When assessing and interpreting the level of bankruptcy risk for a company under investigation all results obtained should be compared.

Table 6 presents overall results of the research.

Table 6. Presentation of the research results

Model	2016	2017
Mączyńska'a MAD model Z_M E. – O.Jacobs function	COMPANY IS FUNCTIONING WELL Index value: 1.2627	RISK OF BANKRUPTCY Index value: -2.1506
Model Z₇INE PAN	RISK OF BANKRUPTCY Index value: -3.0665	RISK OF BANKRUPTCY Index value: -9.2916
Model Z₆INE PAN	RISK OF BANKRUPTCY Index value: -2.3704	RISK OF BANKRUPTCY Index value: -8.5623
Model Z_{HCP} „Poznański”- M. Hamrol, B. Czajka, M. Piechocki	RISK OF BANKRUPTCY Index value: -0.9494	RISK OF BANKRUPTCY Index value: -3.8794

Source: Authors' research.

Each of the above models has the same classification for an entity at bankruptcy risk; i.e. when the value of the discriminant function is below zero, the company is at risk of bankruptcy within a year. Only in one case – for the data for 2016 – a model does not predict bankruptcy, while the other seven results show clearly a bankruptcy risk. The analysis of the results shows a trend that in 2017 the results are worse than in 2016. Probably, wrong management decisions led the company to crisis in 2017 and its financial results deteriorated significantly.

One can find information on the Internet that the Qumak company applied to court for bankruptcy on 31 October 2018¹⁹ and on 5 February 2019 the Warsaw District Court, 10th Commercial Court Department for Bankruptcy and Restructuring declared bankruptcy of the Qumak company.²⁰

The presented above case of the company shows the significant role of early-warning models in the assessment of a financial situation. All models that were applied for the data for 2017 predicted bankruptcy of the company in 2018 and they were right.

¹⁹ <http://wyborcza.biz/Giedy/1,132329,24116106,qumak-zlozyl-wniosek-o-ogloszenie-upadlosci-ale-wciaz-liczy.html?disableRedirects=true>, (accessed: 01.11.2019).

²⁰ <http://syndykpiotruda.pl/?p=618>, (accessed: 01.11.2019).

Discriminant functions can predict company financial crisis situations in a simple and prompt way. Thanks to such models companies can in advance implement remedial actions to get out of crisis.

When analysing the situation in any company, it is worth using several early-warning models to make the analysis of financial situation more reliable.

Conclusions

The issue of company bankruptcy is particularly significant in the time of crisis. Every company would like to protect itself against a crisis situation, which can be supported by the implementation of early warning-models.

Discriminant models that are used to forecast bankruptcy are applied increasingly more often by various groups of stakeholders as an assessment tool of company's financial situation. They are simple, easy to apply and highly effective in forecasting financial risks.

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Abstract

The article presented the effectiveness of the four selected company bankruptcy early-warning models , as illustrated by the QUMAK company. The financial analysis of the company was based on the company's financial reports for fiscal years 2016 and 2017 that were completed on 31 December.