Effectiveness of the financial management in terms of R&D activities across selected stock companies in Poland

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Abstract: The purpose of the study is to determine the financial impact of expenditure on research and development activities (R&D) of selected companies listed on the Warsaw Stock Exchange. The work is based on reports of 44 such companies, which conducted R&D activities between 2015 and 2017. Expenditure on R&D was taken as a diagnostic variable in the assessment of a given company's management efficiency. The financial condition was assesed using three diagnostic indicators: the return of assets, current liquidity levels and debt ratio. The two first were assumed to be stimulants, while the third was taken to be destimulant. A scoring method—recommended among others by M. Tarczyńska-Łuniewska and W. Tarczyński—was used to construct a complex measurement of the overall financial condition. The methodology adopted was based on the results of studies conducted by (among others) Baruch, Hurwitz, Lines and Schmidt, Walczak, as well as Glova, Dancakova and Suleimenova. The results observed made for an examination of a subtle relationship between financial results of the companies with the levels of R&D activities conducted. It was found that there was no significant impact of research activities on the financial condition and management effectiveness of the selected enterprises.

Keywords: R&D activities, intangibles, listed companies, financial performance, business excellence

1. Introduction

Business management effectiveness was taken to refer to the degree of achieving predetermined goals and the pace of adaptation to changes taking place in the organizational environment (Grudzewski and Hejduk, 2002; Wawak, 2001). When testing effectiveness, any final outcomes of decisions previously made by managers are examined mostly in relation to the economic dimension (financial performance, financial condition of the company) (Drucker, 2006). It is generally assumed that better tangible results and healthier financial conditions of a selected company (including its cor-

porate value) provide a measure of the effectiveness of management (Borowiecki and Siuta--Tokarska, 2017).

To describe and accurately measure business management effectiveness, comprehensive methods can be used, such as an analysis of Key Performance Indicators (Parmenter, 2015). These contain a set of financial and non-financial indicators on the basis of which it is possible to measure degrees of achievement of predetermined objectives, both for the whole company and for particular segments of the given organization (Grycuk, 2010). Other examples of multi-criteria models used to assess management efficiency are (among others), the Business Excellence Model (Dahlgaard and Dahlgaard, 1999) and as subsequently modified, i.e.: the Business Excellence Framework (Dahlgaard et al., 2013), and the FACT model (Mohammad et al., 2011). The 4P excellence model (Dahlgaard and Dahlgaard, 1999) and the Balanced Scorecard method (Kaplan and Norton, 2001) are also tools to measure effectiveness of a selected company's operations. Some companies score highly for efficiency and management performance, according to various indicators (both qualitative and quantitative) (Zymonik, 2012). In the USA, the Malcolm Baldrige National Quality Award is accorded to companies on the basis of the MBNQA Model, which measures the quality of management (NIST, 2020). On the other side of the Atlantic, the European Foundation for Quality Management (EFQM) is the kitemark for continental European ventures. This model enables a company to score its level of competitiveness and business excellence (EFQM, 2019).

Qualitative indicators are becoming increasingly important for the purposes of analyzing the business management efficiency. Q.I.'s take into account factors such as knowledge management processes, information processes, methods of building intellectual capital, relations in the organization, research and development activities, organizational culture, and others (Grabara and Dima, 2012). An increase in the value of non-measurable factors may sometimes determine the company's development (Lev and Sougiannis, 1996). As underlined by Dahlgaard and Dahlgaard (1999), an analysis of a company's management efficiency should refer primarily to strategic future-oriented indicators. Key goals of strategic management are searching for new solutions and launching new products (Porter, 1998; Griffin and Pustay, 2005), but may extend to "creating" new markets, e.g. blue ocean strategy (Kim and Mauborgne, 2005). Companies embarking on such endeavours often become leaders in their respective industries, overtaking competitors, because they are able to anticipate changes in technology and global trends (Haryanto and Haryono, 2015). Innovation activities significantly enhance business and finance performance because investment in research activities increases (Hult, Hurley and Knight, 2004). Therefore, the amount of expenditure on research and development (R&D) and the effectiveness of the same may prove to be key factors determining business management efficiency (Krause, 2016).

R&D provides a reliable basis for analyzing enterprises in various ways. The Eurostat classification (Eurostat, 2016) divides industry into four categories, taking into account the level of R&D expenditure in turnover. Industries in which R&D expenditure accounts for over 5% of the market share is referred to as "high-technology" industries, while "medium high-technology" industries represent those with a 3–5% share of R&D expenditure, "medium low-technology industries" are those with a 1–2% share of R&D, and "low-technology industries" are those trailing with a 1% or less share of R&D. According to the European

Commission (2016), the most advanced are electromechanical and pharmaceutical industries, along with sectors providing IT and telecommunications services (Eurostat, 2016).

In the paper, the following hypotheses were verified: The intensity of spending on research and development activities has a direct positive impact on the company's financial condition. In the following years, more and more enterprises conduct more intensive research and development activities.

2. Materials and methods

In this study, an analysis was made of one selected indicator—i.e.: spending on research and development activities (R&D). For our research purposes, the International Accounting Standards (IAS aka IFRS) encompasses activities aimed at acquiring and developing knowledge and applying it in practice. Additionally, development activities may be related to the design, implementation and testing of various prototypes, tools, products or new solutions.

This article analyzes results of a sample of companies listed and registered in the Polish National Court Register. In all, 44 companies listed on the Warsaw Stock Exchange (GPW) were selected for analysis of their R&D expenditures in the stock reports published in 2015, 2016 and 2017. The companies were chosen from the electromechanical, pharmaceutical, IT, chemical and biotechnology sectors.

The authors adopted expenditure on R&D as a diagnostic variable for the assessment of the given company's management efficiency. Expenditure on R&D related to development works constitute a part of those of intangible assets of the enterprise (intangibles), which the Accounting Act (consolidated text from 2013, item 330, Art. 3, par. 1, point 14) defines as "proprietary copyrights, related rights, licenses, concessions, rights to inventions, patents, trademarks, utility and decorative designs, know-how, acquired goodwill and costs of completed development works".

Baruch Lev (2001) developed a method for analyzing performance intangibles based on GAAP[1] financial reporting, and this method may be applied to measure the intangible performance of Stock Exchange enterprises. This method was later developed by Hurwitz, Lines and Schmidt (2002), who reached the conclusion that adapting an appropriate strategy for using intangibles directly or indirectly affects stock returns. Walczak (2010) emphasized the importance of such an approach in order to maximize the given company's value to shareholders and other stakeholders. Similar issues were analyzed by Glova, Dancakova and Suleimenova (2018) and Mrazkova (2018) in their studies, which tested the hypothesis that there is a relationship between R&D expenditure and business value.

For the purposes of this study, the financial condition of the selected company was taken to be the determining measure of management effectiveness. The financial situation was assessed using three diagnostic indicators: the return of assets, current liquidity levels and the debt ratio. The return on assets and current liquidity were assumed to be stimulants, while the level of debt was taken to be a destimulant. These ratios were calculated in accordance with generally accepted models (Sierpińska and Jachna, 1994), i.e.: the return on assets as a quotient of the financial result and total assets, the current liquidity as a quotient of current assets and short-term

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[1] Generally Accepted Accounting Principles—financial statements prepared in accordance with US standards. They allow the company to enter the New York Stock Exchange and access other American capital markets.

liabilities, and the debt ratio as a quotient of total liabilities and total assets. A scoring method was used to construct a complex measurement of the overall financial condition (Tarczyński, Tarczyńska-Łuniewska and Tarczyński, 2017). This exercise depends on assigning a specific score for each factor, depending on the relative importance of that factor. In terms of the chosen enterprises, an appropriate score was applied, reflecting the values calculated for particular years, according to the formal criteria (as in Table 1), where: ROA_A, CR_A, DR_A are matched to ROA, CR and DR respectively for company A, while d_{ROA}, d_{CR} and d_{DR} represent the average deviation of ROA, CR and DR, in the respective group of companies surveyed. As a complex measure of the company's situation, the scores accorded to individual diagnostic measures were adopted. If the sum was less than 4, then the company was placed into group 1, i.e.: companies in the weakest financial condition. If the sum was between 4 and 6, then the company was placed into group 2 (i.e.: poor financial condition). If the sum was between 7 and 9, then the company was placed into group 3 (i.e.: good financial condition). The companies in the strongest financial conditions were placed into group 4, where the score was at least 10.

Table 1. Scoring method for selected indicators for company A

Diagnostic measure	The range of the value adopted by the measure in company A	Assigned score
Return of assets (*ROA*)	$ROA_A < 0$	0
	$0 \leq ROA_A \leq \overline{ROA} - 0.5d_{ROA}$	1
	$\overline{ROA} - 0.5d_{ROA} < ROA_A \leq \overline{ROA}$	2
	$\overline{ROA} < ROA_A \leq \overline{ROA} + 0.5d_{ROA}$	3
	$\overline{ROA} + 0.5d_{ROA} < ROA_A$	4
Current ratio (*CR*)	$CR_A \leq \overline{CR} - 0.5d_{CR}$	1
	$\overline{CR} - 0.5d_{CR} < CR_A \leq \overline{CR}$	2
	$\overline{CR} < CR_A \leq \overline{CR} + 0.5d_{CR}$	3
	$\overline{CR} + 0.5d_{CR} < CR_A$	4
Debt ratio (*DR*)	$DR_A \leq \overline{DR} - 0.5d_{DR}$	4
	$\overline{DR} - 0.5d_{DR} < DR_A \leq \overline{DR}$	3
	$\overline{DR} < DR_A \leq \overline{DR} + 0.5d_{DR}$	2
	$\overline{DR} + 0.5d_{DR} < DR_A$	1

S o u r c e: Authors' own elaboration based on: Sudoł, 1999; Woźniak (ed.), 2002; Sierpińska and Jachna, 1994.

Based on the methodology developed by Sudoł (1999) and Woźniak (ed., 2002), the companies analyzed were divided into four groups depending on size, total assets, revenue and number of employees. In the case of the companies surveyed, these results strongly correlate with each other each year, as shown in Table 2.

Table 2. Linear correlation matrix between revenue, total assets and the number of employees in the companies surveyed in particular years

2015	R	A	Ne	2016	R	A	Ne	2017	R	A	Ne
R	1	0.97	0.91	R	1	0.99	0.93	R	1	0.97	0.91
A	X	1	0.97	A	X	1	0.96	A	X	1	0.97
Ne	X	X	1	Ne	X	X	1	Ne	X	X	1

S o u r c e: Authors' own elaboration.

Where the values examined strongly correlate with one another, it suffices to use one criterion (size of the company) in order to divide companies into groups. In such cases, revenue was taken to be the key criterion (Table 3).

Table 3. Criteria for assigning company A to groups (by size)

	Scope of assumed value of revenue in company A	Group (by size of the company)
Revenues (R)	$R_A \leq \bar{R} - 0.5d_R$	(1)—the smallest companies
	$\bar{R} - 0.5d_R < R_A \leq \bar{R}$	(2)—small companies
	$\bar{R} < R_A \leq \bar{R} + 0.5d_R$	(3)—big companies
	$\bar{R} + 0.5d_R < R_A$	(4)—the largest companies

S o u r c e: Authors' own elaboration.

The financial intensity of R&D activities was measured by the share of expenditure on turnover (or revenue activities) of the company. The companies were divided into four groups in terms of their size and level of intensity of R&D funding (Table 4).

Table 4. Criteria for assigning company A to groups (by intensity of R&D expenditures)

	Scope of assumed value of share of expenditure on R&D activities in company A	Group (by intensity of R&D financial activities)
Share of R&D expenditure in turnover (E)	$E_A \leq \bar{E} - 0{,}5d_E$	(1)—the smallest intensity
	$\bar{E} - 0{,}5d_E < E_A \leq \bar{E}$	(2)—small intensity
	$\bar{E} < E_A \leq \bar{E} + 0{,}5d_E$	(3)—large intensity
	$\bar{E} + 0{,}5d_E < E_A$	(4)—the highest intensity

S o u r c e: Authors' own elaboration.

The relationship between the size of the company and the intensity of R&D funding, and then the relationship of the same with the company's financial performance was assessed by comparing the categorization of objects into specific groups, taking into account the criteria adopted.

3. Results and discussion

For 2015, the groups marked as 1, 2, 3 and 4 were classified as 30, 13, 5, and 4 companies, respectively. The results dictated the majority of the companies analyzed to be placed into the first group ("the smallest companies"). For 2016, the results were 30, 13, 4 and 5 companies respectively, and for 2017, the totals were 32, 11, 3 and 6 companies using the same respective breakdown. While examining the relationship between the size of the company and intensity of R&D activities, a slight negative correlation can be observed, i.e.: −0.41 for 2015, −0.36 for 2016 and −0.30 for 2017. This indicates that there is a small negative correlation between the size of the company and the intensity of its R&D funding activities. Smaller companies were characterized by a slightly higher degree of R&D activities. However, the research conducted showed that there is no substantive relation between the size of the company and its financial condition—the correlation coefficient model did not exceed 0.12.

The proportion of expenditure on R&D in the turnover of the selected companies was lower than the Eurostat assumption for high, medium-high, medium-low and low technology sector divisions. The maximum level of expenditure on R&D in the turnover of the surveyed companies in 2015, 2016 and 2017 was 35.32%, 43.97%, 42.32%, respectively. However, the medians in individual years were: 0.59%, 0.93% and 0.70%, while the first quartile reached the value of 0.12%, 0.04%, 0.03%, and the third quartile 2.27%, 2.61%, 2.28%. This means that, in percentage terms, the selected company's financial commitment to R&D activities did not exceed 2.65% of turnover in any of the periods analyzed.

In 2015, 34 out of the 44 surveyed enterprises fitted into group 1 of R&D funding intensity. Eight were on a par with group 2, and three companies slotted into group 3, while there were seven companies in group 4. In 2016, 29 companies belonged to group 1, 14 companies to group 2, three companies to group 3, and six to group 4. In 2017, there were 30 surveyed enterprises in group 1, ten in group 2, three in group 3 and nine in group 4. Most companies were

characterized by low levels of R&D activities. There were no clear trends (both upward and downward), and overall it may be assumed that the companies surveyed did not pursue strategic plans in terms of R&D activities, and undertook such activities in an ad hoc manner, perhaps in response to a need to modify products/ services or a desire to cooperate over R&D activities.

Our research did not establish a clear relationship between the level of R&D funding activities and the financial condition of the given company.
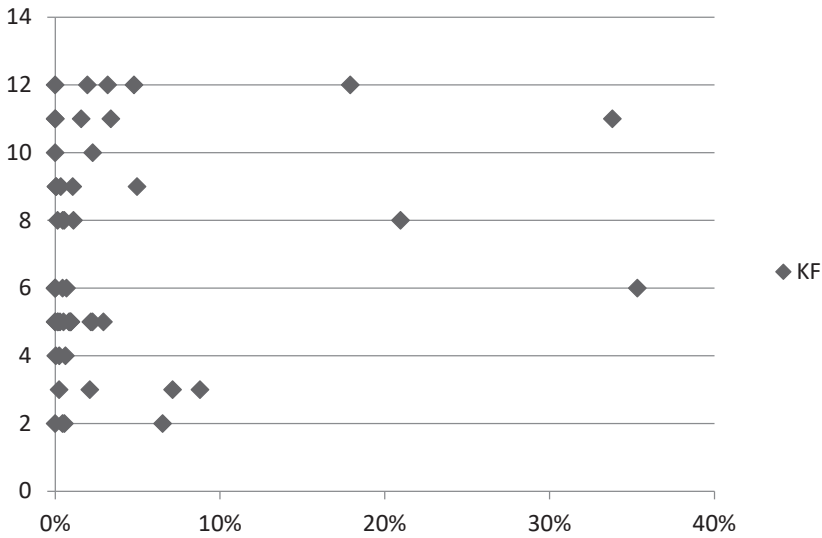

Figure 1. The measurement of levels of R&D activities against the financial condition of the enterprises in 2015

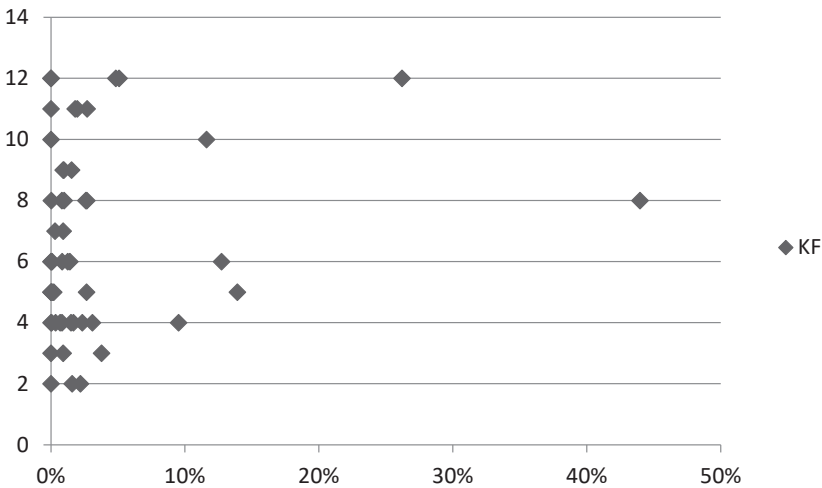S o u r c e: Authors' own elaboration.

Figure 2. The measurement of levels of R&D activities against the financial condition of the enterprises in 2016

S o u r c e: Authors' own elaboration.

Table 5. Intensity of R&D activities and the financial condition of the enterprises surveyed

		Intensity of research and development activities (E)			
		$E = 1$	$E = 2$	$E = 3$	$E = 4$
		2015			
Financial condition	$K_f = 1$	4	1	0	0
	$K_f = 2$	18	3	0	5
	$K_f = 3$	8	0	1	1
	$K_f = 4$	4	4	2	1
		2016			
	$K_f = 1$	3	2	1	0
	$K_f = 2$	15	6	0	3
	$K_f = 3$	7	3	0	1
	$K_f = 4$	4	4	2	2
		2017			
	$K_f = 1$	4	3	0	0
	$K_f = 2$	10	3	2	4
	$K_f = 3$	11	1	3	1
	$K_f = 4$	5	3	0	4

S o u r c e: Authors' own elaboration.

The results presented in Table 5 illustrate a slight decrease in the number of companies with the lowest levels of R&D funding of the highest degree. In the group of companies with the lowest level, there is an improvement in the financial condition in 2017 as compared to 2015. The same trend can be observed in the case of companies with the highest levels of R&D. In the group of companies classed as groups (2 and 3 in terms of R&D activities), there was a slight decrease in the proportion of companies in a stronger financial condition, as opposed to those in a weaker position. Despite the lack of evidence of a determination to increase R&D activities, some indications of improvement can be observed. The same can be said of the financial condition of companies conducting more intensive R&D activities (Table 5).

4. Conclusions

Based on the research and results, it is apparent that there is a small negative association between the size of a company and the relative financial level of R&D activities in the selected period. Smaller sized companies are characterized by a slightly higher intensity of R&D activities. The research conducted did not reveal a clear correlation between the size

of the company and its financial (management) robustness. Moreover, the analysis did not indicate that there is a tangible relationship between the E and K_f indicators. When the results were analyzed so as to determine a linear correlation between grouped companies according to the level of R&D activities against the financial condition of the enterprise, it was found that none of the cases exceeded a reading of 0.135. Therefore, the hypothesis that the intensity of research and development activity has a direct positive impact on the company's financial condition has not been confirmed. The hypothesis that more and more companies in the next few years conduct more intensive research and development activities has been partially confirmed.

5. Limitations and suggestions for future research

Based on the conducted analysis, the following recommendations for further research are made:
1. Research and development activities are oriented towards the implementation of long-term goals, therefore an analysis of management effectiveness should be made taking into account a longer time interval.
2. To effectively analyze business excellence, it is necessary to take into account not only quantitative but also qualitative results that have a significant impact on competitive advantage. Reports published by listed companies do not take into account such data, and the reporting procedure itself makes it difficult to obtain uniform data from listed companies.
3. The complex measurement of a company's financial condition through the scoring method can be used for further research, and should address the question of how levels of R&D activities are likely to develop in the near future (5–10 years). It is also necessary to compare the impact of the levels of R&D on the financial condition of a given company using 3 and 5-year time periods.

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Finansowa skuteczność zarządzania przedsiębiorstwem w świetle działalności B+R wybranych spółek giełdowych w Polsce

Abstrakt: Celem pracy jest określenie wpływu wydatków na działalność B+R na kondycję finansową wybranych spółek notowanych na Giełdzie Papierów Wartościowych w Warszawie. Do analizy wybrano raporty 44 polskich spółek giełdowych, które w latach 2015–2017 prowadziły działalność badawczo-rozwojową. Nakłady na działalność B+R stanowiły w analizie zmienną diagnostyczną oceny sprawności zarządzania spółką. Do oceny kondycji finansowej wykorzystano trzy wskaźniki: rentowności aktywów, płynności bieżącej i stopnia zadłużenia, przy czym dwa pierwsze są stymulantami, trzecia destymulantą. Do skonstruowania miary syntetycznej kondycji finansowej wykorzystano metodę scoringową, zalecaną między innymi przez M. Tarczyńską-Łuniewską i W. Tarczyńskiego. Przyjęta metodyka opiera się na wynikach analiz prowadzonych przez m.in. Barucha, Hurwitza, Lines i Schmidta, Walczaka, a także Glovę, Dancakovą i Suleimenovą. Dokonane analizy pozwoliły zaobserwować niewielką zależność między wynikami finansowymi badanych spółek a intensywnością ich działalności B+R. Oznacza to, iż nie stwierdzono istotnego wpływu działalności badawczej na kondycję finansową oraz na skuteczność zarządzania. Opracowano model diagnostyczny, który może posłużyć do analizy skuteczności zarządzania w dłuższej perspektywie czasowej, będącej istotnym elementem planowania strategicznego.

Słowa kluczowe: działalność B+R, aktywa niematerialne, spółki giełdowe, wynik finansowy, skuteczność zarządzania