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CONTENTS

VERIFICATION OF EARLY WARNING MODELS ON ENTERPRISES FROM THE SEZS EUROPARK MIELEC

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Abstract: In this article the authors focus on the verification of models for forecasting bankruptcy of enterprises. 30 enterprises located in the Mielec zone were surveyed. Early warning models were used in the study, including 6 discrimination models and 4 logit models. The purpose of the article is to verify the effectiveness of selected models for forecasting the bankruptcy of enterprises that operate in the Mielec special economic zone. The financial data came from the period 1999-2017. It should be noted that "healthy" enterprises, i.e. those in good financial condition, operate in the zone to date. The conducted research shows that the selected models correctly reflected the financial situation of the surveyed enterprises (Institute of Economic Sciences of the Polish Academy of Sciences model of F. Mączyńska and M. Zawadzki 80% accurate forecasts, and the model of J. Gajdka and D. Stos 73.3%). The authors point out the need to use many analysis models to reliably assess the financial situation of enterprises. If only one model is used, the results may lead to erroneous conclusions.

Keywords: financial situation of an enterprise, early warning models, company bankruptcy forecast, special economic zone.

Introduction

Mielec SEZ belongs to the group of leading industrial zones in Poland. It is located in a town of 61 thousand, located in the south-eastern part of Poland, in Podkarpackie Province. The zone creates favourable conditions for new investments, both domestic and foreign. In addition to aviation, the dynamically developing sectors in the zone include automotive, metalworking and plastics processing. The largest foreign investors are companies from the USA, Germany, Austria and Italy.

The areas covered by the status of special economic zones, at the end of December 2004, covered an area of approx. 6526.3 hectares (i.e. 0.02% of the country), they occupied the

territory of 79 cities and 55 rural municipalities. According to the legal status, as at December 31, 2017, the total area of areas covered by Special Economic Zones could not exceed 25,000. ha (i.e. 250 km2), and the period of their existence was determined by the end of 2026 (PARP, 2018).

It is worth mentioning that the Polish Investment Zone replacing the previous SEZ is an instrument that is designed to support the sustainable development of the Polish economy. In accordance with the Act of May 10, 2018 on supporting new investments, the existing permits to conduct business activities in Special Economic Zones (SEZ) remain in force until the end of 2026 (Waćkowska-Kabaczyńska, 2019). The newly created tool stimulates areas that have been defined in the Strategy for Responsible Development (among others: stimulation of entrepreneurship, innovation of companies, or foreign expansion of Polish enterprises).

The reason for researching the enterprises of the Mielec zone, created as one of the first in 1995, are the authors' scientific interests in the activities of zone companies that efficiently attract foreign capital, and more often implement new technical and technological solutions, thus affecting the competitiveness of the manufactured products and services rendered.

The process of continuous adaptation to changing environmental conditions (including legal, fiscal or administrative regulations) and increasingly demanding customers are the requirements that 21st century enterprises must meet.

At a time when a different political system prevailed in Poland (centrally planned economy) the phenomenon of bankruptcy did not occur.

The turn of the1990s in Poland brought about important political changes in the country. The fact is that the transition from a centrally planned economy to a market economy gave Poland a chance to modernize the country. One of the tasks was to reduce the distance in relation to the highest and most developed EU countries.

In 1997, the social market economy was recognized as the constitutional basis of the Polish economic system, and the inspiration was the experience of Germany, which, drawing on the doctrine of ordoliberalism, built a social market economy and achieved spectacular success after World War II (Przybyciński, 2009, p.192).

Immediately after 1990 there was widespread enthusiasm for starting new private companies; this enthusiasm is measured at an economical level through entrepreneurial indicators – in the short term, the number of private companies increased, but, as enthusiasm was not always a good substitute for managerial skills and experience, many newly-founded companies faced bankruptcy (Pirtea, 2003).

The phenomenon intensified with the appearance of periods of recession in the country, when the financial policy was upset, which could have resulted in the company's insolvency. Taking into account the above changes and phenomena, the article attempts to assess the effectiveness of selected models for forecasting the bankruptcy of enterprises, companies from Special Economic Zones of Europark Mielec, using 6 discriminative models (as the most popular tools) and 4 logit models.

Literature review

Many different models have been formulated in the theory and practice of predicting business bankruptcy (in economic terms of bankruptcy). McKee (T.E. McKee, 2000) presented an exhaustive classification listing the following types of procedures and models:

- one-dimensional indicator models,
- multidimensional discriminatory analysis,
- linear probability models,
- logit and probit models,
- decision trees,
- gambling models,
- expert systems,
- mathematical programming,
- neural networks,
- application of the theory of fuzzy sets and rough sets.

The first Polish discriminatory model whose task was bankruptcy forecast was E. Mączyńska's model. The author used a multiplication model of simplified discriminant analysis to predict the bankruptcy of Polish companies (Mączyńska, 1994). The creation of the model was associated with the adaptation of E. Altman's western model (or Z-score model) to Polish conditions. Thanks to E. Altman, a precursor in forecasting threats to the functioning of enterprises, we can talk about the dynamic development of early warning models.

A developed application of Fisher's linear discriminant function is the bankruptcy prediction model for Polish companies presented in the work of Gajdka and Stos (1996), where the sample of industrial enterprises surveyed was equal to 40 entities, half of which were bankrupt, and the other half – "healthy", listed on Warsaw Stock Exchange.

Discriminant analysis methods are free from one major drawback to indicator analysis, namely the difficulty of clearly and accurately assessing a company's financial position. According to T. Korol, the most effective method in forecasting the bankruptcy of companies among all statistical methods is multidimensional discrimination analysis (Korol, 2010, p. 158). At the same time, current research allows the conclusion that there is not actually one correct model for assessing the threat of bankruptcy of an enterprise (Mączyńska, Zawadzki 2006, p. 228). The table below is presented, detailing the research of selected authors with the largest number of discriminatory models used, as well as the number of enterprises surveyed.

Table 1.
Characteristics of selected studies according to the largest number of discriminatory models used and the number of enterprises surveyed

Author of the study	Number of models used	Number of enterprises surveyed	Number of enterprises surveyed bankrupt or threatened with bankruptcy
P. Antonowicz	41	208	90
R. Balina	27	60	30
G. Gołębiowski, K. Żywno	25	10	10
O. Rusek	23	6	6
R. Balina, J. Pochopień	22	40	
A. Czarny	21	26	
D. Mirowska, M. Lasek	21	30	15
L. Czapiewski	20	94	48
E. Grzegorzewska, H. Runowski	10	51	
W. Lichota	10	5	

Source: Kitowski, 2017, p. 181.

The above data show that the most numerous population of discriminatory models used in the study (41) and the number of enterprises (89 companies declared bankrupt and 119 companies not at risk of losing their financial condition) was examined by P. Antonowicz (Antonowicz, 2010, p. 19); then L. Czapiewski, who examined 94 companies, 48 of which were threatened with bankruptcy, and 46 enterprises were in good financial condition (Czapiewski, 2009, p. 123), and R. Balina, who used 27 discriminatory models to study 60 enterprises, including 30 at risk of bankruptcy (Balina, 2012, p. 233-234).

The results of the study showed the effectiveness of individual models. Not all of the verified models achieved the effectiveness of results above half. Therefore, not all of the models used can be considered fully effective, because the results below 50% of the effectiveness of diagnoses show a high probability of getting an incorrect diagnosis. From the study, only the three best models in this respect can be considered reliable, and their effectiveness above the 65% threshold may give hope for getting the correct diagnosis. In the case of other tools (even those that exceeded the performance threshold above 50%), such chances significantly decrease.

The conducted research results and their confrontation with the declared prognostic values of the authors themselves and with other research results may indicate that early warning models have a certain useful life. They have remained highly effective since their inception for a certain unspecified period of time. None of the studies carried out brings the exact period, whether it is 4, 5 or 8 years from the time of its creation.

The obtained results and their comparison to other applications of this type show that despite the huge range of different tools used to assess financial condition and forecast it in the future, only some of them can actually be used. In the case of the conducted research, only three of all the models used were effective at a level that provided adequate results.

Research sample and research methodology

The basis for all the methods used in the article was the analysis of existing data. The analysis includes: a systematic review of the literature, analysis of public data, including data of the Ministry of Economy, and financial data on enterprises (primarily income statement, balance sheet).

Based on the collected financial data, 30 enterprises located in the Europark Mielec SEZ – i.e. 15 bankrupt and 15 termed "healthy"; 10 early warning models were verified (6 discriminative models and 4 logit models).

The selection of enterprises, apart from operations in the same zone, also concerned a similar business profile, the number of employees, and the size of assets. All enterprises operated (operate) in the broadly understood industrial sector. The financial data came from the period 1999 - 2017. It is also worth adding that healthy enterprises still operate in the zone. The model of R. Jagiełło was selected for discriminatory models. The author, while creating the model, took into account the specifics of the industry in which a given company operated.

The following models were evaluated:

Discriminatory models:

- model of M. Pogodzińska and S. Sojak

Z_{PS} = 0.644741W1 + 0.912304W2

W1 = (Current assets - Inventories) / (Short-term liabilities)

W2 = (Gross result) / (Sales revenues)

ZPS > 0 good financial condition

ZPS < 0 bankruptcy threat (Pogodzińska, Sojak, 1995);

- model of S. Sojak and J. Stawicki

ZSS bad = -11.6499 - 0.1144W1 + 0.5178W2 - 20.4475W3 - 0.0661W4

ZSS average = -2.3333 - 0.0586W1 - 3.3608W2 + 10.7088W3 + 0.1455W4 - 0.066W5 + 4.5837W6 + 2.4329W7

ZSS good = -5.992 - 0.0153W1 + 2.0482W2 + 9.637W3 + 0.1714W4 - 0.0091W5 - 15.78W6 - 0.0018W7

W1 = (Net profit) / Current assets average) * 100

W2 = (Current Assets - Inventories - Short-term prepayments) / (Short-term liabilities)

W3 = (Average annual working capital) / Average annual assets)

W4 = (Net profit) / (Equity average) * 100

W5 = (Net profit) / Non-current assets average) * 100

W6 = (Net result + Interest on foreign capital - income tax) / (Average assets)

W7 = (Current assets) / (Short-term liabilities)

ZSS > 0 good financial condition

ZSS < 0 bankruptcy threat (Sojak, Stawicki, 2001);

- model of J. Gajdka and D. Stos

ZJG2 = -0.0005W1 + 2.0552W2 + 1.7260W3 + 0.1155W4 - 0.3342

W1 = (Short-term average annual liabilities - 360) / (Production costs)

W2 = (Net profit) / (Annual assets)

W3 = (Gross profit) / (Sales)

W4 = Assets / Liabilities

ZJG2 > 0 good financial condition,

ZJG2 < 0 bankruptcy

-0.49 <= ZBP =< 0.49 – uncertainty area, no definition of the financial situation (Stos, Gajdka, 2003).

- B. Prusak's model

ZBP = -1.5685 + 6.5245W1 + 0.148W2 + 0.4061W3 + 2.1754W4

W1 = (EBIT) / (Assets)

W2 = (Operating costs) / (Short-term liabilities)

W3 = (Current assets) / (Short-term liabilities)

W4 = (EBIT) / (Total revenues)

ZBP >= -0.13 good financial condition,

ZBP < -0.13 bankruptcy

-0.13 =< ZBP = < 0.65 "area of uncertainty", no determination of the financial situation (Prusak, 2005);

- Model "F" of the Institute of Economic Sciences of the Polish Academy of Sciences E. Mączyńska and M. Zawadzki

Z_{EM2} = -2.478 + 9.478W1 + 3.613W2 + 3.246W3 +0.455W4 + 0.802W5

W1 = EBIT / (Assets)

W2 = (Equity) / (Assets)

W3 = (Net profit + Depreciation) / (Liabilities)

W4 = (Current Assets) / (Short-term liabilities)

W5 = (Total revenues) / (Assets)

ZEM2 > 0 good financial condition,

ZEM2 < 0 bankruptcy (Mączyńska, 2006);

- R. Jagiełło model for the 'Industry' sector

W = -1.8603 + 12.296W1 + 0.1675W2 + 1.399W3

W1 = Profit (loss) on gross sales / Operating expenses

W2 = Total revenues / Assets

W3 = Equity / Assets

With < 0 there is a high probability that this company will be classified as at risk over the next year

Z > 0 company not in danger of bankruptcy (Jagiełło, 2013).

Logit models:

- T. Korol model

ZTK = 2.0 - 10.19W1 - 4.58W2 - 0.57W3

W1 = Profit on sales / Assets

W2 = (Net profit + Depreciation) / Liabilities

W3 = Operating costs / Short-term liabilities

ZTK <= 0.5 good financial condition,

ZTK > 0.5 bankruptcy.

This is a conventional limit value, because the author himself did not specify such a level. The value of 0.5 was due to the fact that the learning sample roughly contained a 50%/50% bankrupt/non-bankrupt ratio. Hence the limit value adopted in this way (Korol, 2010).

- model of D. Wędzki

ZDW = -4.0 - 6.0W1 + 9.387W2 - 2.088W3 + 1.317W4 + 0.04W5 - 4.217W6

W1 = (Current assets + Prepayments) / (Short-term liabilities and Special funds + Prepayments and deferred income)

W2 = (Provisions + Long-term liabilities + Short-term liabilities and Special funds + Accruals and deferred income) / Assets

W3 = Interest payable / (Profit (loss) on business activities + Interest payable)

W4 = [Net profit (loss) / Equity] / [(Net profit (loss) + Interest payable * (1- Obligatory encumbrances on the financial result / Gross profit (loss))) / Assets]

W5 = Short-term receivables * Number of days in the period / Net revenues from sales

W6 = Profit (loss) on sales / Net revenues from sales

ZDW =< 0.5 good financial condition,

ZDW > 0.5 bankruptcy (Wędzki, 2005).

- M. Gruszczyński model,

on the form of the function: ZMG = 4.3515 + 22.8748W1 - 5.5926W2 - 26.1083W3,

W1 = Gross profit/Total revenues

W2 = Liabilities/Assets

W3 = Inventory/Total revenues

where: ZMG > 0, the audited entity is in good financial standing (Gruszczyński, 2003)

- P. Stępnia and T. Strąk model,

on the form of the function: ZSS = −19 - 11W1 + 6W2 + 40W3 + 19W4,

W1 = Foreign capital/Total capital

W2 = (Current assets - Inventories)/Short-term liabilities

W3 = Net profit/Total capital

W4 = Sales revenues/Operating expenses

where: ZSS > 0, the examined entity is in good financial standing (Stępień, 2004).

Results of empirical research

Based on a sample of 30 surveyed enterprises, calculations were made for 5 research periods. Due to the volume, the results are presented only for the last study period. It was the year in which the "bankrupt" enterprises announced their liquidation.

Five consecutive reporting periods of enterprises were examined, of which the most recent (the last period analyzed) was the year of declaration of bankruptcy by the enterprises belonging to its bankrupt group.

The table below presents the classification of all models, assuming the accuracy of the results for the last year of the test.

Table 2.
Classification of early warning models according to the accuracy of the diagnosis – last year of the study

Model	Number of correct grades	Number of incorrect ratings	Number of incorrect ratings		Percentage of accurate forecasts
			First degree error	Second degree error	
Model "F" of the Institute of Economic Sciences of the Polish Academy of Sciences E. Mączyńska and M. Zawadzki	24	6	1	5	**80%**
Model of J. Gajdka and D. Stos	22	8	2	6	**73.3%**
Model of R. Jagiełło	20	10	4	6	**66.7%**
Model of Sojak and Stawicki	18	12	7	5	**60%**
Model Stępnia and Strąka	17	13	5	8	**56.7%**
Model of T. Korol	16	14	6	8	**53.3%**
Model of D. Wędzki	16	14	5	9	**53.3%**
Model of B. Prusak	16	14	7	7	**53.3%**
Model of M. Gruszczyński	13	17	6	11	**43.3%**
Model of Pogodzińska and Sojak	12	18	6	12	**40%**

Source: author's own study based on the survey results obtained.

As the data show, for the last year of the study the model of the Institute of Economic Sciences of the Polish Academy of Sciences of E. Mączyńska and M. Zawadzki with 80% forecast accuracy, and the J. Gajdka and D. Stos model with 73.3% accuracy were characterized by the highest prognostic reliability. These models correctly diagnosed the financial condition of enterprises in the proportion of 24 correct to 6 incorrect results in the first model, and in the case of the second model 22 to 8. The obtained results show the classification of early warning models used by the authors according to the accuracy of the diagnosis for the last year of the study.

Noteworthy is the fact that 8 out of 10 models have obtained prognostic reliability of over 53% and more, except for the model of M. Gruszczyński (43.3%) and the model of Pogodzińska and Sojak (40%). It can be seen that in the analyzed period none of the models had a predictive effectiveness above 80%.

In the case of both examined groups of enterprises, i.e. healthy and bankrupt ones, guided by the criterion of their financial condition, researchers can make an appropriate or incorrect diagnosis, which results in the occurrence of a 1st and / or 2nd degree error. Occurring in the case of an incorrect diagnosis – 1st degree error concerns the incorrect allocation of enterprises in good financial condition to a group of bankrupt (bankrupt companies), and the second degree error concerns the incorrect assignment of enterprises referred to as bankrupt to enterprises in good financial condition. The discussed errors considered in the category (ex ante), prediction errors (ex post), indicate an incorrect classification of the surveyed enterprise in the set time horizon (Pociecha, 2007).

In most models, a second degree error was more common than a first degree error. In only one model was the situation opposite (Sojak and Stawicki's model). In one of the models the number of incorrect diagnoses of the first and second kind was the same (B. Prusak's model).

Summary

The actual state of the economic crisis severely affected young Eastern European private companies, including in Poland. The uncertainty of the medium- and short-term situation of a company caused unwanted market blockages (Slavici, Maris, Pirtea, 2015, p. 387). The need for a good forecasting tool for the bankruptcy of Eastern European companies thus arises. Several authors used neural networks to meet this need, including Darvasi (2010), Dorneanu et al. (2011).

The results of the research, which aimed to assess the effectiveness of selected models for forecasting the bankruptcy of enterprises from the Mielec SEZ, confirm the validity of the research. Each of the 10 models used obtained 50% or more prognostic reliability.

None of the models in the same period was more than 80% effective. The selected models properly reflected the financial situation of the surveyed enterprises (the model of the Institute of Economic Sciences of the Polish Academy of Sciences of E. Mączyńska and M. Zawadzki obtained as much as 80% of accurate forecasts, and the model of J. Gajdka and D. Stos 73.3%).

In most models, the second degree error was more common than the 1st degree. The reverse occurred in only one of the models. In only one of the models was the number of incorrect diagnoses of the first and second kind the same.

Studies show that the time of creation of the model is not the main determinant of its effectiveness. Models that were created earlier assess the financial situation as well as models

that were created later. Therefore, it is difficult to determine the useful life of a given model. However, one should not forget about the choice of methods to assess the financial condition of enterprises, which is dictated naturally by industry matching. Its task is to reduce the risk of incorrect model mapping.

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THE CAREER OF A FEMALE MANAGER

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Abstract: The article discusses issues related to the contemporary approach to the professional career of a female manager. A special focus has been placed on the conditions influencing the shaping of women's careers. The findings of own research on the perception of women's careers at managerial positions in modern companies are presented. The considerations are complemented by an attempt to interpret the reasons for the approach to women's careers.

Keywords: career, manager, woman.

1. Introduction

Women who decide to pursue their careers are obliged to accept both the benefits and the costs of entering employment. This is reflected in their private lives. For some, a career is a chance for self-development and to increase their own abilities and skills on professional grounds. For others, participation in social reality is the essence of gainful employment. By achieving successes in the professional sector, they gain a higher social status. Many arguments that encourage women to participate in the multi-sectoral market expansion appeal to defend their gainful employment. The motives and reasons that encourage women to become active in the labour market outline a broad spectrum of topics, as well as problems, related to career and its implementation. It seems that in today's world, it is essential to earn a living by working, but in this case, it is essential to treat work properly. According to the research conducted by the **Central Economic Information Centre** (Centralny Ośrodek Informacji Gospodarczej, 15.04.2011), 37% of companies are owned by women. Psychologists emphasise women's greater resilience to stress, ability to act under pressure from multiple tasks, along with better work organisation and teamwork skills. It seems, therefore, that entrepreneurship is not lower than in the case of men, although it does not result in promotions. Women are most often owners of small businesses (they run two-thirds of them) (http://www.gk24.pl/, 31.01.2012), which shows that they feel better in flat organisational structures and that there are barriers to their promotion to positions in large organisations. This phenomenon has been

called the 'the glass ceiling effect' — an invisible, but significant, barrier prohibiting women from occupying higher positions. Women's careers resemble a pyramid or a glass mountain, which is impossible to climb, and the prospects indicated by the trends of recent years do not seem optimistic. Although in Poland women become managers more often than the average in EU countries (there are six percentage points more of them in these positions), we are slowly reaching the low EU average level. Over the last five years, the number of female managers has decreased by 3% (Centralny Ośrodek Informacji Gospodarczej, 08.03.2012).

The aim of the article is to draw attention to the conditions influencing the shaping of professional careers of women and to examine the perception of professional careers of female managers in modern companies.

2. Modern approach to career development

Career is a priority value in the life of most of society today and has an impact on an individual's life (Wiatrowski, 2005). A career is a way of treating work as an opportunity for self-development and, as D. Gizicka (Gizicka, 2009, p. 325) highlights, is a value that is a vital source of life satisfaction. On the other hand, M. Suchar (Suchar, 2003, p. 38) defines work as an autotelic value when it is a source of joy and satisfaction for a human being and, at the same time, creates a chance for the self-fulfilment of an individual. It is often said that work gives self-esteem and an opportunity to demonstrate oneself. Many people identify a sense of work with a sense of life. However, on the contrary, professional activity can be treated by a human being in an instrumental way and can only be a means to achieve other goals.

The transition to the era of capitalism resulted in profound changes in the performance of work, where the most important features have been flexibility of time and place, an employee's contacts with the employer, remuneration system and employee skills. The flexibility of work has resulted in millions of people becoming 'temporary' workers who have been forced to take on unsecured working methods that are not favourable to forming a professional identity. As a result of increased capitalism, relational employment contracts are now transitioning towards transaction contracts. Its very nature is to exchange the short-term involvement of the employee in the achievement of the organisation's objectives for the possibility of pursuing an individual career in that organisation. However, it should be pointed out that an employee's career development still depends to a large extent on the organisation where he or she works. The employee is, however, forced to create their own sense of security, usually independently and through their own responsibility, building up their identity as the bearer of a specific capital (Tomaszewska-Lipiec, 2016, p. 146).

According to P. Bohdziewicz, an employee functions in the social space in its broad sense and should create a personal reputation as a professional in a given field. The three major

directions of change describing the process of transition from a traditional to contemporary career, which are based on entrepreneurial individuality, include (Bohdziewicz, 2010, pp. 41-42):

- the development of loyalty, referred to as a professional type, instead of organisational loyalty,
- the person's focus on achieving internal rather than external awards,
- reliance on oneself during the process of career progression, not on the hiring organisation.

New trends in career development theory seem to be based on constructivism and social constructionism. These theories relate to the subjectivity, the agency of the individual, the attribution of meanings, the mutual relations between the individual and the environment (McMahon, 2014).

In light of discussions on globalisation, internationalisation and indigenisation, which also apply to career theory, a criticism of the current most leading career development theories is being made, pointing to their limitations. They include (Leung, Yuen, 2012):

- focusing on personal variables, without taking into account contextual and cultural variables,
- considering self-fulfilment and job satisfaction as objectives of professional choices,
- highlighting the significance of free choice and opportunities in decision-making,
- development of culturally ingrained practices and measures that are difficult to adapt in other contexts.

As M. McMahon points out, one of the dominant trends in career psychology is that it takes little account of the values of "social justice" (McMahon, 2014, p. 15). This approach means that the careers of women and ethnic minorities, for example, are not sufficiently taken into account and that this trend in psychology cannot therefore be widely adopted in other cultural contexts. Critics of such approaches to career psychology stress the underestimation in theories of the influence of factors such as gender, social status, environmental context, family conditions or cultural characteristics on the course of individual careers (Blustein, 2011, p. 19).

3. Professional career and gender

The gender of an employee has an impact on the development of a career. Most careers are gender specific. This group includes stable, conventional, unstable and multi-faceted careers. There is, however, a set of careers that are specific only to women, where one can distinguish between home, dual and interrupted work careers. They are largely dependent on biological aspects, i.e., starting a family, giving birth to children, as well as social aspects, such as

involvement in the family, dealing with the household, raising children. The characteristics of the above-mentioned careers are presented in Table 1.

Table 1.
Work career patterns by gender of employees

CAREER PATTERNS	CAREER DEVELOPMENT
A stable career	For men, it is an early start to a full career, with no preparatory work period. Maintained successively for the following years is characteristic for professionals, managers and officials. In the case of women, this is about taking up a job after graduation and looking at work as a role to fulfil in this stage of life.
A conventional career	It is a career shaped from temporary employment, through probationary periods to stable employment. At this point, the activity belongs to managers, skilled manual workers and officials. As far as women are concerned, this is about taking up a job after graduation and is an escape from staying at home.
An unstable career	For men, this career development provides for alternating probationary employment, and possible stabilisation should be treated in the short term. It is typical of semi-skilled workers and lower-level officials. As far as women are concerned, it is related to those who represent workers with a low socio-economic status, and it is also related to taking up and leaving work according to their financial situation.
A multi-faceted career (many attempts)	In the case of men, it refers to unstable employment, consisting of constant changes in employment. It is typical for unskilled people. In the case of women, family needs are among the causes of frequent changes in employment.
WOMAN-ONLY SPECIFIC WORK CAREERS	
A home career	A career that is determined by the requirements of the home and a job that is secondary and not successful for a long time. It is where a career ambition has been reflected in the family field.
A dual career	It is a characteristic feature of women who achieve successes in the professional field, and starting a family has limited the development pace and found stability between work and involvement in the family.
An interrupted career	In this case, the family situation forces women to stop working or to be less engaged in work. However, if the conditions are favourable, the woman can return to employment again.

Source: Bańka, 2000, p. 314.

Due to changes in the nature of the psychological contract, strengthened by the character of modern careers, there is a significant development of new types of careers. These are mainly concepts related to, e.g., intelligent careers, boundaryless careers, protean careers and kaleidoscopic careers. A mutual characteristic of these is the attribution of responsibility for one's professional career to the employee. The conditions that are distinctive of capitalism affect the preferred attitudes of employees towards their careers (Tomaszewska-Lipiec, 2016, pp. 146-147).

Faced with a choice between participating in professional life and starting a family, twenty-first-century women choose to be professionally active (with such a high divorce rate as nowadays, the opposite choice would be financially unjustified) (Wittenberg-Cox, Maitland, 2010, p. 44).

Additionally, these studies (Hewlett, Buck, 2006, p. 13) have shown that women feel unwell when they are financially dependent on their spouses. Whether or not their relationship is successful, most of them do not like asking for money. Nearly half of the surveyed women (46%) admit that having one's own independent source of income is an important factor encouraging them to work.

4. The career perception of female managers

E. Lisowska (Lisowska, 2009) claims that a woman has a limited life choice, which is already culturally determined. In Poland, values such as home and family are respected, but this is a key reason why Polish women are still overshadowed by men, despite increasingly better education.

When analysing the reasons for combining a career and motherhood, it is worth drawing attention to opinions concerning women's work. According to the figures, more than two-fifths (44%) of those surveyed believe that working women have greater social respect than housewives who are only involved in housekeeping and childcare. The opposite opinion is expressed only by 5% of respondents. It is also worth noting, though, that despite quite frequent beliefs about the greater social role of economically active women than those who take care of children and work in the household, almost three quarters of respondents (74%) do not differentiate respect for women depending on their professional status (CBOS, 28.09.2016).

The author conducted her own research in Polish companies in the years 2013-2016 in order to examine the perception of women in managerial positions. The survey included 228 randomly selected respondents whose task was to estimate the degree of acceptance (on a scale of 1-4) of the statements (Table 2).

Table 2.
Statements concerning the perception of women in managerial positions

NO. OF THE STATEMENT	STATEMENT	POINTS 1 - definitely not 2 - rather not 3 - rather yes 4 - definitely yes
1.	Women are more interested in their jobs than their careers.	
2.	A high level of challenge and job satisfaction is more important for women than promotion.	

Source: own elaboration.

The results of the research, taking into account the number of respondents' answers, are presented in Table 3, while their interpretation is presented in Table 4.

Table 3.
The number of respondents' answers

NO. OF THE STATEMENT	RESPONDENTS' ANSWERS			
	definitely not	rather not	rather yes	definitely yes
Statement 1	29	71	86	42
Statement 2	18	51	104	55

Source: own elaboration.

Table 4.
The interpretation of research results

THE PERCEPTION OF WOMEN IN MANAGERIAL POSITIONS	ACCEPTANCE OF THE STATEMENT	INTERPRETATION WITH PERCENTAGE OF RESPONSES
1. Women are more interested in their jobs than in their careers.	**DEFINITELY NOT and RATHER NOT**	Women **are not** more interested in work than in careers according to **44%** of respondents.
	DEFINITELY YES and RATHER YES	Women **are** more interested in the job itself than in the career according to **56%** of respondents.
2. More attention paid to high level of challenges and job satisfaction than to promotion.	**DEFINITELY NOT and RATHER NOT**	According to **30%** of the respondents, women **do not** attach more importance to high level of challenges and job satisfaction than to promotion itself.
	DEFINITELY YES and RATHER YES	According to **70%** of the respondents, women **are** more attached to high level of challenges and job satisfaction than to promotion.

Source: own elaboration.

The research conducted by the author shapes the image of a woman as more interested in her work than in her career. This opinion is confirmed by 56% of respondents. In addition, according to 70% of respondents, managers pay more attention to high level of challenges and job satisfaction than promotion itself.

Seeking the reasons for such an approach to a woman's professional career, the question arises: what is the reason for perceiving women as those who attach more importance to work, high level of challenges and job satisfaction than to career and promotion?

The answers to this question can be found in the results of research conducted by B. Budrowska, D. Duch and A. Titkow (Budrowska, Duch, Titkow, 2003, pp. 88-91), who, in their report, published the barriers and limitations related to the development of careers of Polish women. These are:

- the omnipresent assignment of women to traditional roles — women and men, representatives of business and politics, share the view that motherhood is the cause of women's reduced availability;

- stereotypical views on women's nature — men emphasise and uphold the cultural pattern of femininity as delicate, gentle and sensitive and treat their rapid decision-making as impatience;
- men's attitude towards women in the context of mutual cooperation — different assessment of their own and men's work. The assessment of women consists of two assessments: the assessment of the cultural shaping of femininity and the assessment of substantive work. Women also feel protectionism from men, disrespect, envy and jealousy about achievements;
- beliefs about women and men as bosses — a female boss is more concerned about work organisation and teamwork. Some women cannot imagine 'managing a man'. Women also often use non-substantive arguments and psychological games, which makes some women prefer male bosses;
- the status of male and female solidarity — there is often strong male solidarity and a lack of female solidarity, which may be due to the lack of women in positions dominated by men. And if there is already a group of women, rivalry begins instead of building solidarity.

From another perspective, perhaps it is the women themselves who are to blame? Observation shows that the key barriers to women's job promotion are a lack of self-confidence and self-esteem, as well as submission to opinions and prejudices of the environment. Well-known surveys show that almost half of men consider themselves to be exceptionally or very ambitious, with only one-third of women thinking so, although this percentage is growing consistently, especially among those working in business, where 43% of respondents admit to having a high level of ambition. In the race to the top, they therefore lose out to men, even though they are well educated and have the knowledge and skills to hold key positions in companies.

5. Conclusion

In the recruitment process, and later when applying for promotion, a woman will hear that it is not a role for her, that women are not good leaders, directors, etc., or that such a role will make it worse for her to function as a mother, there is a great risk of launching a negative autostereotype. Indeed, women will be worse off in competitions or assessments, because there is stress that they will confirm this stereotype, and they will not be good enough as managers, and at the same time, they will become worse mothers. It may also be a desire to prove to men that in a managerial role, they are as good as men are. This willingness to prove their competence, as well as additional pressure, results in less concentration and attention to the task. In such cases, women do in fact perform worse, because additional thinking about the

difficulties arising from their role reduces their ability to process data. It is, to some extent, women's own responsibility not to let themselves and others run a stereotypical pattern of their gender in an emotionally difficult situation, but to concentrate on their achievements and successes — trying not to think of themselves as simply a woman but as a person who has experience and will cope with the task ahead of her (Raport…, p. 14).

Due to the above, there is a lack of consistency and ambiguity in the approach to a professional career pursued by women in managerial positions.

The results of research conducted by Deloitte, supported by numerous analyses, indicate that stereotypes and lack of understanding of the benefits of their participation in management have a significant impact on the poor position of women in company management. However, the research also shows that men are better promoted as those in power — due to the extortion strategy they use to build their careers in companies. Even in top managerial positions, men do not stop applying pressure, fighting and breaking resistance. On the other hand, in relations with subordinates and co-workers, chairwomen and female board members behave differently — they use consultations to inspire the team and use methods of rational justification. They apply them much more often than men in similar positions (Frańczak, Georgijew, 2012, p. 17 & next).

In recent years, a new phenomenon has been observed with regard to those women who have already taken up top positions in a company. However, these successful managers often leave the company despite being at the top and start their own businesses. This escape from the highest levels to their own business is called a *careerpreneur*, *corporate incubator* or *corporate climber* (Terjesen, pp. 246-259). The most common reasons for women leaving a company are wage inequality, frustration with organisational restrictions and the need for greater flexibility (Vinnicombe, Bank, 2003).

When considering the professional career of women, it is worth noting that they are often assigned to support functions jobs and are rarely in positions directly linked to executive decision making. Women are assessed on the basis of professional skills, not managerial skills, and this is the direction in which their careers are most often shaped from the very beginning. At present, a number of measures are being undertaken in order to equalise the rules of functioning of women and men in business. The evolution of the management approach will make it possible to achieve an effective balance in managerial positions, which will save a lot of frustration for ambitious and successful women not wishing to lose their femininity.

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IDENTIFICATION OF SOURCES OF KNOWLEDGE ABOUT DISRUPTIONS IN INTERMODAL TRANSPORT

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Abstract: Intermodal transport networks, as examples of business networks created in supply chains, are differentiated not only due to types of key resources in the organization, but also due to such things as network structure, the nature of the organizations involved, the types of relations they have, and the roles of individual actors in the network. The business network is understood as a dynamic system whose configuration depends on the fulfilment of particular tasks and the competencies of the organizations which form them. Such networks are inherently temporary, because a new task can initiate the creation of completely new inter-organizational bonds or change the type of pre-existing relations between network nodes. The cooperation of enterprises in a freight transport network compels one to look at the problem of knowledge management in a wider context. The paper focuses on the first stage of knowledge management, which is knowledge acquisition in an organization and its environment. The paper presents the idea of gathering knowledge, and identification of the sources of disruptions in an intermodal network.

Keywords: intermodal transport, disruptions, logistic network.

1. Introduction

Contemporary European transport policy definitely stresses the necessity to develop inter-branch and balanced transport systems. These guidelines include intermodal transport, which involves transporting loads in one invariable loading unit on the entire transport route, using mainly those branches of transport which generate smaller external costs. However, achieving intermodal transport requires commitment from many entities and the creation of an interorganizational transport network. Such interrelations may consist of not only competition, but also collaboration between entities to determine the success and realization of planned activities and assumed aims. However, the considerable complexity of intermodal transport networks makes them susceptible to disruptions at different stages of material flows. These disruptions can vary in nature, impact and origin, and can be generated by every participant in the network. Due to the significant influence on the reliability of realized flows,

it is essential to gain knowledge about disruptions in order to allow networks to establish a resilience to them. In connection with the above, this paper aims to design a model of managing knowledge about disruptions in intermodal transport networks. In order to achieve such a goal, three detailed exploratory questions were assumed:

- What disruptions are characteristic for intermodal transport networks?
- What are the sources of disruptions in intermodal transport networks?
- Which actors of the network should be included in a disruption monitoring system?

Obtaining answers to the above research questions and fulfilling the assumed objective will allow further research into the resilience of intermodal transport networks.

2. Interorganizational networks in intermodal transport

For decades management sciences have been leading investigations into the nature of interorganizational networks. They are defined as networks of enterprises, economic networks or business networks (Kawa, 2013, p. 77). The literature broadly described the reasons for, and potential advantages obtained from functioning within networks. However, a consensus emerged that an organization's results are no longer able to be based only on the internal resources and possibilities of an enterprise, but they have to be widely based on resource flows and relations to other entities in the market (Centenaro, Guedes Laimer, 2017, p. 66). Consequently, the network approach changes the field of exploration by shifting the source of the competitive advantage from the inside of an organization to the outside of it, and there it focuses on single network links, their relations, and adopted methods of cooperation or organization (Czakon, 2015, p. 11). Referring to the above statements, according to W. Czakon (2015, p. 11), the expression of attained superiority due to its functioning in the network could be called a network pension, and treated as a definite distinguishing characteristic trait of the network.

"Network" is a key notion in the network approach, and it means a number of units connected within a system of many different connections (Guzdek, 2016, p. 193); it is a set of actors connected by a set of bonds (Czakon, 2012, p. 15); it is a specific form of connections among entities, based on correlations, cooperation and confidence (Antonowicz, 2016, p. 76). According to the IMP Group (The Industrial Marketing and Purchasing Group), a network is a set of long-term formal and informal (direct and indirect) connections (relations) which appear between two or more entities (Kawa, 2013, p. 77). In another study, A. Kawa and B. Pierański (2015, pp. 24-25) stress that an interorganizational network is formed by at least three independent entities and the bonds appearing among them. However, A. Buttery and E. Buttery (1994, p. 17) indicate two or more organizations connected with relations which influence all participants of the network. Supply networks are a type of network where material flows play a key role. They are defined as: "a system built from nodes cooperating with one another in

order to increase the geographical range of influence, market penetration, activity diversification, and an increase in the innovativeness of the offered products and services" (Kramarz, Kramarz, 2015, p. 61).

In connection with the fact that the functioning of interorganizational networks has become a characteristic trait of any contemporary economy, it must be stressed that network activity is performed by enterprises representing different kinds of business activity in the market. An example is a transport business represented by different branches, concerning both passenger and freight transport. In connection with the above, it is essential to define the notion of a "transport network". The literature most frequently presents this it through the prism of connections in the form of roads, railway lines, or air links within a punctual infrastructure (Kawa, 2013, p. 333). Also, D. Bernacki (2012, p. 674) identifies transport networks with sets of transport units and transport connections appearing among them in the form of transport routes. However, in the presented depiction, a transport network is not understood as compatible with the network approach known from management sciences.

In this paper, transport networks will be identified as groups of entities connected to one another by formal and informal relations. These can have vertical and horizontal connections. The former concern enterprises interrelated in the "supplier-recipient" relation. Flows occurring between them mainly concern objects and information, thus creating a supply chain. The latter concern entities which represent the same business activity, offer the same or similar products on the market, but participate in different supply chains (Kawa, 2013, p. 335). D. Ford and S. Mouzas (2013, p. 436) stress the significance of relations in established interorganizational networks. Firstly, they indicate that they cause a decrease in the separation of entities in the network. Moreover, they treat relations as primary assets, such as financial or physical ones, which are also valuable to the economic entity. Additional relations have a considerable influence on the activation and development of performed activities and possessed resources. J. Rześny-Cieplińska (2010, pp. 226-227) treat transport business enterprises building networks as a form of adopted strategy for creating competitiveness in the market. Moreover, in her opinion, networks within which transport enterprises perform activity should be classified according to several criteria, for instance: property, participation conditions, the scope of activity, and the type of activity. In the context of the last criterion attention should be paid to the significant number of different networks to be formed. They are, for example, networks built within a given transport branch or their combination. Consequently, there appears an idea of intermodal transport networks as part of contemporary transport policy, which stresses the necessity to build an integrated and balanced multi-branch transport system. Again, attention should be paid to defining an intermodal transport network not concurrent with the approach in management sciences. M. Janic (2007, pp. 33-34) defines an intermodal transport network as a set of nodes of intermodal character together with flows of consolidated loads appearing among them, such as containers, exchangeable semitrailers or bodywork, involving the utilization of at least two branches of transport. The main participants of such a network are supposed to be: senders and recipients of loads, operators of trans-shipping terminals, and transport enterprises which

physically realize transport as part of different branches of transport. However, similarly to transport networks, this paper looks at intermodal transport networks of a different nature, taking into account the building of interorganizational networks based on horizontal relations between units. In such a depiction, an intermodal transport network will be defined as a set of entities representing a widely understood branch of intermodal transport together with the relations appearing among them. These entities will in practice be connected with different branches of transport used in freight traffic (road, railway, inland navigation, sea, air freight). In such a network the leading actors will be: forwarding agencies (in individual branches of transport), transport forwarders, including intermodal transport (within different transport relations, e.g. road-railway), logistics operators offering full service of loads, also taking into account transport tasks, operators of intermodal terminals (railway, sea, air and inland waterway terminals), and administrators of linear infrastructure or customs agencies.

The notions of networks, supply networks, transport networks, and intermodal transport networks introduced in this part of the paper, compatible with the network approach in management sciences and their relationships, are presented in Figure 1. Supply networks are the broadest context for analyzing relationships for material flows. Within them, various supply chain configurations can be identified (Fig. 1). In addition, it must be noted that transport networks are interorganizational relationships offering activity for various configurations of supply chains appearing in practice. This is connected with the complementary part of transport service visible in every branch and at each level of the load flow in supply chains. It is different with constructed networks of intermodal transport, which firstly do not have to fulfil their own role for each supply chain, and secondly do not complete their task at all levels of the flow. What is meant here are mainly deliveries to the final customer, identified as the consumer, which enter into the scope of functions and issues of so-called last mile freight. Intermodal transport is not used in it.

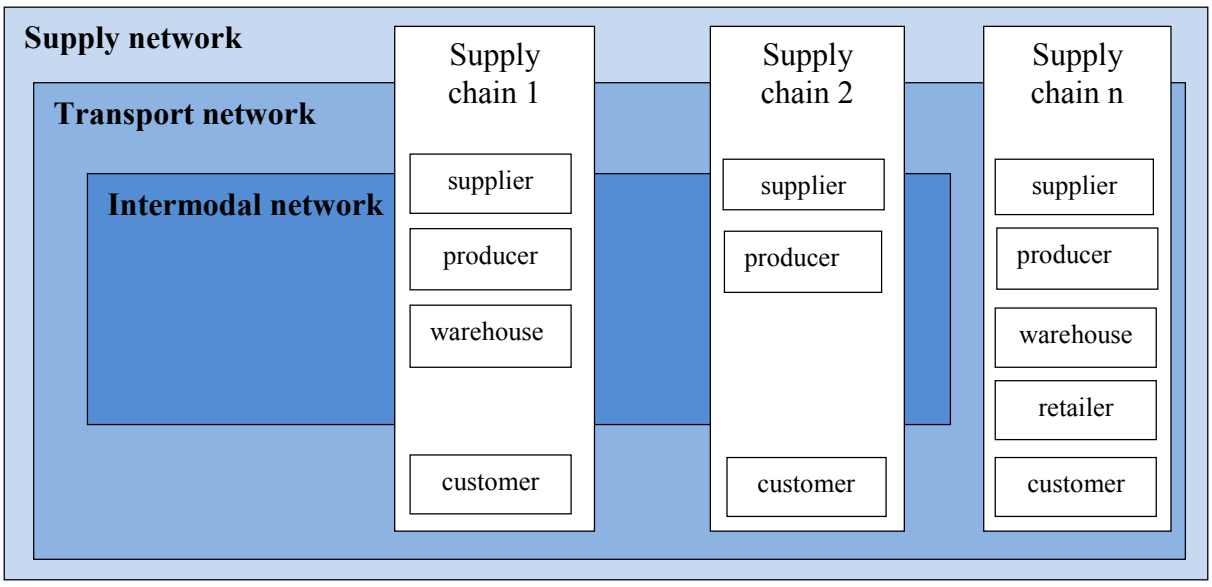

Figure 1. A transport network versus an intermodal transport network. Source: authors' study.

The activity of contemporary transport markets, including especially of the intermodal character, requires close co-operation and partnership among haulage operators, and with other entities participating in the process of transport and logistics service. The necessity to provide customers with complex services at high quality level involves building transport networks which consist of various entities. Their mutual collaboration allows full co-ordination and the improvement of material and informational flows (Antonowicz, 2011, p. 14). The contemporary transport market is global in nature, represented by enterprises with different capital whose range is international. It is a challenge for building collaborative networks due to the considerable complexity of managing such an international network. This is associated with cultural differences and business practices in individual countries where network participants come from (Guzdek, 2016, p. 196). Also, W. Downar (2010, p. 103) stresses the enormous complexity, multi-agent approach, organizational variety and strong external and internal connections in transport activity. Consequently, it requires interactions between organizations which are directly or indirectly connected with offering transport services. The complexity of the process of providing the customer with value demands a new approach to transport management. One of its guidelines is to build permanent, formal or informal relations based on collaboration and confidence. Especially small and average enterprises, representing the same segment, build collaborative networks in order to increase their own competitiveness in the market. This is associated with access to external partners' resources (Centenaro, Guedes Laimer, 2017, pp. 66, 69-70), and replacing or supplementing competitive relations with those based on collaboration.

M. Antonowicz (2016, p. 77) defines intermodal transport as a service system and characterized as the collaboration, cooperation and partnership of all entities participating in the service regardless of the number of chain links involved. These entities have a various character. They are inter-related by long-term relations, add values to the transport as part of their activity, and often take the role of suppliers and recipients in relation to one another. The network approach towards intermodal transport assumes that the organizational results are no longer based only on the internal resources and possibilities of an enterprise, but largely on the relations and flows of resources which the enterprise has with other entities in the market. C. Theys, W. Dullaert and T. Notteboom (2008, pp. 1-37) indicate that the success of the development and realization of intermodal transport is strictly connected to the ability to combine loads and coordinate different activities, branches and entities within the intermodal chain. They stress that a multi-branch and multi-agent approach of intermodal transport calls for building collaborative networks of the involved parties. Simultaneously, in their opinion, it is essential to motivate entities to start collaboration within their networks. They refer to costs, which require that the participation of individual entities in collaboration will not cost more than their individual work. They propose using the potential of cooperative game theory for collaborative network analysis within intermodal transport with regard to fair cost sharing among the involved parties. The necessity to collaborate instead of compete in intermodal

transport is also stressed by A. Febrarro (2016, pp. 84-85), who indicates the possibility to exchange real-time information with the use of intelligent transport systems as an advantage of collaborative networks, and notes that the possible supplementary cost resulting from the collaboration of entities can be compensated for by the reduction of storage and waiting time for loading/unloading, or the loading/unloading operation itself.

Also, the literature indicates building intermodal transport networks as a way to reduce external transport costs referring to the negative impact on the natural environment. It is hoped that an efficiently built network will be a chance for the fulfilment of the idea of balanced cities, regions or countries (Yamada, et al., 2009, p. 129). A. Centenaro and C. Guedes Laimer (2017, pp. 66, 69-70) ascribe a special advantage functioning in a network to the possibility of increasing their own competitiveness in the market, which mainly concerns small and average enterprises. Apart from the environmental aspects, they include, for instance: the possibility to reduce transport costs, to improve the quality of transport, an increase in market share, or reduction of the risk connected with performed activities (Serrano-Hernández, at al., 2017, p. 398).

The key role in an intermodal transport network is played by enterprises representing nodes in the form of intermodal terminals; their location, served branches of transport and connections appearing among them are indicated (Munima, Haralambides, p. 89). A similar opinion in relation to the significance of operators of terminals in networks was introduced by R. Šakalys and N. Batarlienė (2017, p. 282). They especially focused on the necessity to synchronize the activities of terminals with respect to place and time. Moreover, they stress the necessity of close coordination of operations among all the involved entities, especially including of the linear and point infrastructure and transport operators. M. Antonowicz (2011, p. 14) also focuses on the part of the infrastructure (mainly including terminals, logistic centres, ports) which is an instrument for creating conditions for concentrating entities interested in offering transport services and providing patency and efficiency of realized flows in the network.

Bearing in mind the indicated conditions of intermodal transport networks, this paper focuses on the issue of disruptions appearing in material flows in such a network.

3. Disruptions and managing knowledge about disruptions in supply chain and transport networks

Disruptions in supply chains are defined as unexpected events which slow down or stop material flows between organizations participating in manufacturing and delivering goods and services (Schmitt, Singh, 2012, pp. 22-32). Y. Sheffi (2005) notes that every type of disruption requires other activities, so, depending on key risk factors, prevention can vary. Sheffi (2005),

while investigating ways in which enterprises can respond to strong disruptions and conduct activities reducing threats connected with disruptions, claimed that:

- Reduction of bottlenecks connected with disruptions occurs through monitoring, early-warning systems (an increase in the sensitivity of a supply chain), and quick reaction to the change of needs, collaboration and redundance;
- operating flexibility is increased through standardization of parts, facilitating their replaceability (product modularity, product designing from the logistics perspective), the postponed production strategy or mass customization of products (multi-variant approach) in response to changes of needs which are difficult to forecast, management of relations with customers and suppliers.

These approaches are an answer to identified disruptions, including their type, frequency and effects, and aim to increase the resilience of the entire system. The effects of disruptions in intermodal transport is a deterioration of the reliability indicators, i.e. certainty, completeness and punctuality of fulfilled transport processes. Gaining and gathering information about disruptions and then processing this information into knowledge which is distributed among the network participants is becoming an essential element of managing the entire intermodal transport network. Gaining, gathering, processing and making knowledge available are elements of knowledge management systems (Chung-Jeng, Jing-Veins, 2007, pp. 104-118).

Regardless of the scope of the knowledge gathered in the network, it is essential to make a distinction between data, information, and knowledge. The idea of imperfect knowledge takes into account inaccuracies, ambiguities, incompleteness, contradictions and untruths from each of the elements of the knowledge pyramid (Krause, Clark, 1993, pp. 3-9; Ackoff, 1989, pp. 3-9). As stressed by Bukowski (2016), data consisting of signs and symbols, recorded, processed and sent, have themselves neither particular meaning nor utility. Only their interpretation decides their value. The information which is a set of sorted, processed, well-ordered data, presented in a form which can be useful for the recipient, has a subjective character because it depends not only on data, but also on the process of their interpretation (Bukowski, 2016; Skyttner, 2008). Knowledge comes into being by integrating new information with the existing knowledge concerning a given area of interest, and requires an ability to assess the available information and understand the reality in light of the available information (Janiszewski, Labroo, Rucker, 2016, pp. 200-208). The skill of effective utilization of the possessed knowledge and experience is defined as wisdom. In this understanding, Table 1 presents an interpretation of individual elements of the knowledge pyramid for disruptions in material flows.

Table 1.
An interpretation of elements of the knowledge pyramid in management of knowledge about disruption

Elements of the pyramid knowledge	Interpretation for disruptions in material flows
Data	Disrupting factors, deviations in material flows
Information	Who is accountable for disruptions? Where do disruptions arise and where are their effects? How often do individual disruptions appear? Which factors strengthen disruptions?
Knowledge	Cause and effect relations between particular disruptions (their force and frequency) and effects (including organizational and financial ones). How were disruptions counteracted? What were the reactions to the effects of disruptions? Which disruptions pose a threat to the reliability of the realized logistic processes? Which activities should be taken to limit the effects of individual types of disruptions? With which force do factors strengthening disruptions affect the effects of disruptions?
Wisdom	What are the effects of using a particular strategy of strengthening the resilience in a given supply chain? What decides about its strong and weak aspects? What is a chance and what a threat?

Source: authors' study.

According to the above-mentioned elements of the knowledge pyramid, knowledge acquisition in intermodal transport networks should combine that found in individual chain links and the existing data, which are then merged to supply a base of knowledge about potential disruptions in intermodal transport networks (Kyriakou, Nickerson, Sabnis, 2017, pp. 315-324). Such knowledge is the basis for risk management in transport networks. The paper defines a transport risk as the probability of an occurrence of an undesirable event which can bring about loss or harm in the object of translocation (risk in the understanding of flow safety), or unpunctual or incomplete fulfilment of an order (in the understanding of network resilience).

This problem is even wider when we look at the system from the perspective of a supply network in which different supply chains work simultaneously, aided by the same transport network. Then the system for managing knowledge about disruptions should be supplied with knowledge about disruptions generated at the level of individual participants of supply chains. These include suppliers, manufacturers, chain links, distribution channels and even final customers. This variant was not taken into account in the conception presented in this paper.

Resistant transport systems are networks which allow reliable fulfilment of transport processes with the utilization of alternative routes in situations when disruptions appear. W. Burgholzer, G. Bauer, M. Poset, and W. Jammernegg (2013, pp. 1580-1586) noted that when planning a transport network, it is essential to identify bottlenecks and design mechanisms for compensating for disruptions. According to them, knowledge about the effects of potential disruptions is precious for decision-making support for the developers of transport projects in order to make them less susceptible and more attractive to all of their users.

Measurement of disruptions and maximization of resilience in intermodal transport networks were also the subject of research by E. Miller-Hooks, X. Zhang and R. Faturechi (2012, pp. 1633-1643), who, when building their model of optimum resilience, identified the resilience determinants of transport networks. While building a stochastic model, they took into

account the location of container terminals. A similar direction of research into intermodal transport networks was chosen by M. Francesco, M. Lai, and P. Zuddas, (2013, pp. 827-837) when also designing a stochastic model. However, they focused their attention on other nodes of the intermodal transport network: ports. Based on the designed model, they created scenarios of material flows in intermodal transport networks.

In the above-mentioned publications researchers identify sources of interference, or sources of risk, in intermodal transport networks. Their analysis allows for a separation of potential disruptions in intermodal transport networks. Therefore, risk in transport processes can be associated with:

- wrong decisions caused by false, unreliable, insufficient and irregular information;
- negligence, ignorance or non-observance of regulations and appointed procedures connected with required documents, binding duties of a haulage operator, the human factor;
- technical factors;
- random factors.

Freight transport is particularly connected with the possibility of threat to goods, damage or loss, which in practice causes a decrease in the safety of material flows. This threat frequently results from the incompetence of the transport enterprise, and more precisely an incompetent, irresponsible worker who allows such threats during the transportation of a commodity. Threats affecting a decrease in safety during the transportation of an entrusted commodity arise through endogenous factors and the influence of the external environment on the transported commodity. Particularly, attention must be paid to such elements as (Romanov, Stajniak, Konecka, 2017, pp. 620-624):

- the technical state of a vehicle;
- the suitable protection of shipment;
- the technical state of roads;
- the driver's skills.

Increasing the security level in transport is influenced by legal regulations. They especially concern the maximum period a vehicle can be driven non-stop, and the frequency and length of pauses in driving. Safety is also directly influenced by: observance of traffic rules, a high culture of driving, maintaining a good physical condition, i.e. eating properly and regularly, valuable rest during pauses in driving.

Potential sources of disruptions, identified in this part of the paper, were described in detail in pilot research, which concerned two subnets of intermodal transport in Poland. The notion of a "subnet" was adopted here in consideration of their fragmentary character in relation to the entire intermodal transport network of working in Poland.

4. Disruptions in intermodal transport based on the example of the Polish intermodal network

Intermodal transport in Poland still has only a slight participation in the structure of freight traffic, yet systematically it is gaining importance. Striving for further development of this idea of transport requires a focus on disruptions which appear in the Polish intermodal transport network. Intermodal transport operations are highly complex and involve a great number of transport service entities. This requires a considerable level of collaboration of the involved enterprises and a high level of operational co-ordination.

Disruptions presented in the paper were identified on the basis of the pilot research for two main subnets functioning within train transport (trans-shipment of containers) and road and sea transport (ferry crossings). Disruptions are separately described in Tables 2 and 3. The former presents disruptions connected with the segment of intermodal transport networks involving strict cooperation between Polish and international operators of train transport together with operators of trans-shipping terminals which form a supranational intermodal network. This network additionally involves numerous road haulage operators, other operators of trans-shipping terminals, and operators and shipowners connected with maritime transport. The entity responsible for organization and management in this type of transport is the network logistic operator, which is a leading intermodal operator which does not realize transport tasks independently.

Table 2.
Disruptions in the Polish intermodal transport network using railway transport

No.	Name	Explanation	Responsible entity
1.	Lack of capacity of the railway line	Connected with poor condition of the railway infrastructure; with lack of a sufficient number of additional tracks at stations to allow passage on one-track lines; emergency locks on some sections of railway lines, especially during night hours; maladjustment of access tracks to European parameters; infrastructure repairs	Administrator of the railway infrastructure
2.	Low priority of container depots in prepared time-tables	Necessity to let all kinds of passenger trailers go first; possible additional decrease in priority in emergency situations	Administrator of the railway infrastructure
3.	Insufficient space on destination railway stations	Small number of additional tracks for stops of train sets awaiting further delivery – necessity to stop train sets on previous railway stations	Administrator of the railway infrastructure
4.	Failure of railway traffic management devices	Infrastructure managers do not comply with the rules regarding the ongoing maintenance and control of relay traffic control devices. The problem appears both at railway stations and on railway lines, which results in a lack of transport safety, and delays.	Administrator of the railway infrastructure
5.	Waiting for taking over train sets between haulage operators of the train transport	Problems with planning, connected with lack of required resources (e.g. engines), cause long waiting time despite earlier train set notification	Railway transport operators

Cont. table 2.

6.	Extended time of shunting works connected with changing engines	Waiting for another engine causes prolonged stoppages at the change station, and the priority falls on the entire train set at further sections of the route	Railway transport operators
7.	Lack of engines at the transfer station	Results from errors in planning and delays	Railway transport operators
8.	Delayed train set from abroad	Caused by many reasons, e.g. lack of engines, lack of staff, loading delays, etc.	Railway transport operators
9.	Waiting for cars	Waiting for groups of cars coming from other terminals to be coupled to the main set	Railway transport operators
10.	Staff problems	Lack of traction team (e.g. no engine driver); lack of authorization on a particular type of engine; lack of knowledge about the route	Railway transport operators
11.	Failures of cars	Regular inspection for incorrectness in the used means of transport	Railway transport operators
12.	Failures of engines	Regular inspection for incorrectness in the used means of transport	Railway transport operators
13.	Lack of an auditor	Lack of a person responsible for technical inspection, inspection of the train set to check its conformity with documentation	Railway transport operators
14.	Lack of the planned train in the SEPE system	The train will not start because it is not visible to the traffic controller and other staff members	Railway transport operators
15.	Damage to containers	The terminal can refuse to accept the train set for trans-shipment and further transport in connection with defects	Operator of trans-shipping terminal/ road haulage operators/railway transport operators
16.	Long and delayed train loading	Despite notification the haulage operator must wait for completion of loading/unloading	Operator of trans-shipping terminal
17	Delays in preparing documentation	Necessity to wait for the delivery of required documentation	Operator of trans-shipping terminal
18.	Weather conditions	Climatic influence is unpredictable, independent from network participants	None

Source: authors' study.

The disruptions indicated in the table do not exhaust the list of all possible disruptions. However, they are key events which appear in the analysed segment of the intermodal transport network. Additionally, disruptions appearing at other levels of the network should also be indicated, e.g. collaboration of road transport entities with operators of trans-shipping terminals and with operators of train transport and with maritime transport operators, etc. Nevertheless, this is not the subject of analysis in this study.

Another example of an intermodal transport subnet analysed from the perspective of disruptions is the collaboration of entities in road and ferry deliveries. This type of activity involves the transportation of loads via road transport to the seaport, followed by trans-shipment of the road conveyance by ferry and, at the last stage, road transport to the recipient. This network consists of: road transport enterprises (forwarding and transport), logistics operators, customs agencies, operators of seaports, and maritime transport shipowners. The identified disruptions are presented in Table 3.

Table 3.

Disruptions in a Polish intermodal transport network with the utilization of road-and-ferry transport

No.	Name	Explanation	Responsible entity
1.	Congestion	The problem of road congestion is still growing, and is additionally a phenomenon which is difficult to predict regarding place and time	Lack
2	Incompatibilities of commodity at loading	Connected with loading too small/too big loads, or loading the wrong commodity. It results in, e.g. delays due to changing of loaded products	Road forwarding/ logistics operator or operators of embarkation points
3.	Incorrectly planned shipment time	Caused by planning the shipment time without regard to the appearance of possible random events	Road forwarding
4.	Lengthened time of waiting for loading	Delays generated in embarkation points despite earlier notification	Operators of embarkation points/ logistics operators
5.	Failures of transport equipment	Regular inspections for faultiness in the used means of transport;	Road haulage operators
6.	Legal problems regarding the driver's working time (e.g. necessity to realize a weekend pause)	Regulations connected with the driver's working time strongly affect the time and punctuality of transport. Transport tasks are planned regarding the working period. However, problems occur, e.g. congestion, which cannot be foreseen, and yet they affect the time of individual activities and consequently lengthen the time of the transport process. Consequently, they affect the available drivers, and the possible working period to be used	Road haulage operators/ road forwarding
7.	Low frequency of ferry crossings on a given line	It results in a decrease in transport flexibility. Moreover, a possible delay for the ferry check-in causes considerable unpunctuality and prolongs the delivery time	Maritime transport operators
8	Driver's working time – lack of possibility to turn the driver's daily pause during ferry crossing	The driver's working time is limited, so it is difficult to synchronize it with the ferry crossing time. There is an alternative solution thanks to which the driver can take the driver's daily pause during the ferry crossing provided it is started while waiting for the crossing in the port. This option is used primarily when the crossing lasts less than 12 hours and when the diel pause should start before the starting time of the crossing beginning	Road forwarding
9.	Duration of ferry crossing	Time is differentiated and depends on the line. Due to the nature of maritime transport, the transport time is relatively long compared to other branches of transport	Largely, disruption of this type results from the nature of maritime transport; however, the directly responsible entities are sea-operators
10.	Cancellation of the ferry crossing	Results mainly from the appearance of inadequate weather conditions	Maritime transport operators
11.	Border check – transport documents	Long waiting time for customs agencies to accept transport documents	Customs agencies
12.	Border check – low availability	Limited opening hours of customs agencies causes a frequent necessity to postpone the border check to the next day	Customs agencies

Source: authors' study.

Similar to the case of Table 2, the list of disruptions indicated in Table 3 is not complete. Further analyses and enlargement of research will allow the supplementation of the list of disruptions both for the presented intermodal transport subnets and other networks not taken into account in the paper.

5. The model of managing knowledge about disruptions in intermodal transport

Consequence plays a very crucial role in the identification of disruptions. It allows for the categorization of all the essential disruptions and threats, and for defining the classes of risks resulting from them. Therefore, it is advised to use different methods which supplement and verify one another. Compelling organizations in a collaborative transport network to share their knowledge is definitely the most difficult obstacle to building a system for managing disruptions in intermodal networks. It requires formalized methods to gain knowledge from commercial and logistic partners, as well as qualitative methods activating the acquisition of secret knowledge. The organization coordinating material flows must possess tools adequate for methods of gaining both open and secret knowledge. Moreover, it is essential to design a methodology of acquiring data, and then converted it into knowledge about disruptions in individual nodes of the supply chain. Organizations usually accumulate data exclusively about deviations in material flows which result from disruptions. Only a certain number of organizations convert those data into information about where and why deviations occur. Both this information and the unprocessed data should be accumulated in one network node.

Disruption studies that take into account disruption management problems, resilience and recovery of freight transport networks, focus on long-term strategic assessments that concern responsiveness to bombs, terrorist attacks, floods, earthquakes and terminal attacks (Serrano-Hernández, Juan, Faulin, Perez-Bernabeu, 2017; Sheffi, 2005). Only a limited number of studies consider the operational level, such as (Skyttner, 2008) who provides a disruption management method while considering road disruptions and their estimated duration (Ambra, Caris, Macharis, 2019, p. 3). Identification of disruptions should occur in real time, so it is necessary to supplement the measurement performed by a computer science system with diary research. The data obtained as a result of the diary research in the chain link where they were recorded should be converted into information on disruptions available for other network nodes. As shown by investigations, computer science systems sometimes tend to record deviations in material flows, ineffectively classifying them to particular sources of disruptions. However, such a connection is necessary in the knowledge base. Disruptions should be recorded in all cooperating links. However, the information transferred to the material decoupling point should be information exclusively about those events whose effects failed to be levelled in the chain link in which they occur. Those disruptions which resulted in deviations from fulfilled processes, which were levelled in

the base enterprise by available methods such as supply chain surplus, subcontracting, extraordinary transport or flexible resources (Kramarz, 2013), should be accumulated in knowledge systems in each organization and made available to the coordinator as open knowledge of this link. Simultaneously, the entire system is influenced by factors strengthening disruptions. They are factors whose source is independent from the system itself. However, the effects of those events strengthen disruptions appearing in the system. This means that endogenous disruptions, whose sources are identified in the intermodal transport system, that is on the level of network actors, cause effects whose consequences will be greater in interaction with exogenous factors (strengthening endogenous disruptions). Exogenous factors especially include natural disasters, atmospheric factors, strikes, blockades, congestion, and changes of legal regulations. Participants of the intermodal transport network do not have any influence on those factors. They must monitor them and accumulate them in a system for managing knowledge about disruptions.

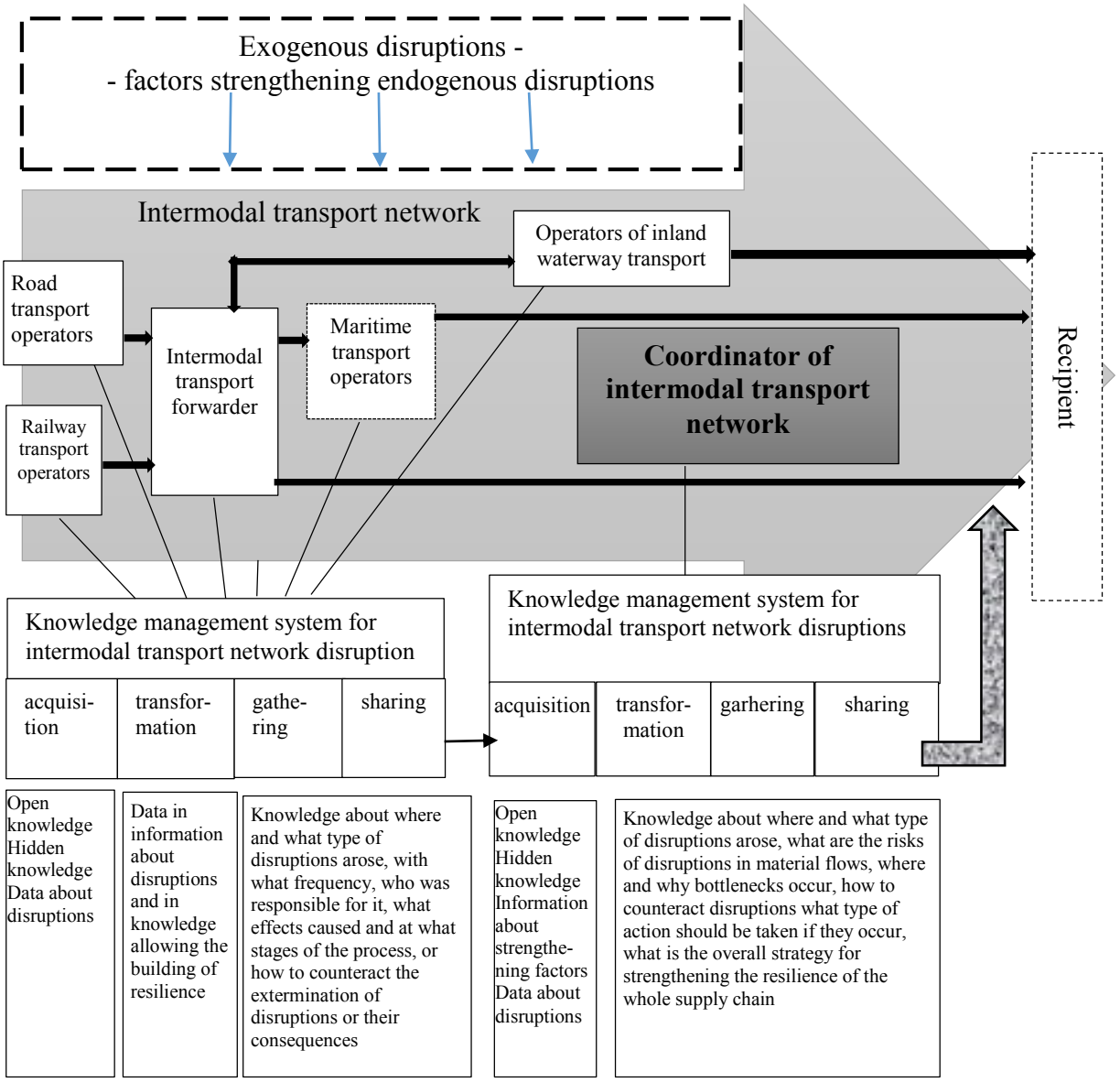

Figure 2. Idea for a system for managing knowledge about disruptions. Source: authors' study.

The presented idea of a system for managing knowledge about disruptions assumes that the knowledge base should be located in the node which has a central position in the network, i.e. one which is a bond of the network. Figure 2 assumed the hypothesis that the coordinator of such a network was the operator of an intermodal transport network. However, the indicating attributes of the coordinator of an intermodal transport network is an object of parallel research into intermodal transport networks, and consequently verification of this hypothesis will be continued in further stages of the research. The introduced idea of a system for managing knowledge about disruptions in intermodal transport networks requires commitment from all partners and knowledge sharing, as well as the unification of measurement of the disruptions in all network nodes.

6. Conclusions

Intermodal transport networks, similar to supply chains and other systems, including single organizations or distribution channels, and due to the key meaning of material flows, they must analyse the susceptibility of the system to disruptions and also build resilience. Building resilience requires on one hand access to data and information on disruptions in all chain links of the system, and on the other hand, possession of knowledge about ways to cope with particular disruptions in order to consequently limit their effects and realize orders efficiently. It is also essential to possess knowledge about intensifiers of disruptions in the network. They are exogenous factors whose sources lie in natural disasters, congestion, weather conditions, blockades, strikes, etc. This paper aimed to design a model for managing knowledge about disruptions which, based on the literature research and pilot studies in two intermodal transport subnets in Poland, is presented in Figure 2. The study indicated the key actors of this network and characterized the stages of gaining, processing, accumulating and making available knowledge separately for individual actors of the network and for the coordinator of the network.

Pilot studies allowed for arranging participants of the intermodal transport network and indicating those entities where it is necessary to monitor disruptions. Simultaneously, they provide more detail for the set of potential disruptions developed at the stage of the literature research. As was noted, it is not a closed set. However, it includes the most common disruptions as well as disruptions causing the most serious effects. The designed system for managing knowledge about disruptions assumes compensating for disruptions in subsequent individual chain links of the intermodal transport network. And those events supply the knowledge base on ways to solve particular problems in material flows. The main information which is combined in the base with knowledge about disruptions are those events, together with their frequency and effects, which spread to other nodes in the intermodal transport network.

The presented results provide a basis for proper research aiming to develop a computer science tool to aid managing knowledge about disruptions in intermodal transport networks. The research led as part of the structure of the system for managing knowledge about disruptions in intermodal transport networks is accompanied by investigations regarding the potential attributes of the coordinator of such a network.

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THE IMPACT OF ORGANIZATIONAL CHARACTERISTICS ON R&D PROJECTS PERFORMANCE IN HIGH-TECH COMPANY

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Abstract: In this study the impact of selected organizational characteristics on R&D projects performance were analyzed. The data for the empirical analysis come from a survey of 131 R&D projects across 53 high-tech business units. This study employs a configurational approach, using fuzzy set Qualitative Comparative Analysis (fs/QCA), to analyze the combination of structural differentiation, innovation strategy, cooperation with stakeholders, and project team autonomy with the performance of R&D projects. The results suggest that no single organizational characteristic is crucial to ensure the success of R&D projects but three causality paths lead to that outcome. Because of significant interdependencies, the main organizational characteristic contributing to the success of R&D projects in the high-tech company concern innovation strategy in connection with either cooperation with stakeholders or project team autonomy or structural differentiation.

Keywords: organizational characteristics, R&D projects, fuzzy-set Qualitative Comparative Analysis (fsQCA), high-tech organizations.

1. Introduction

The Project Management Body of Knowledge Guide (2013) defines a project as a temporary group endeavor that generates a unique product, service or result. The success of project management is the achievement of objectives dependent on budget, quality and methods for the scheduling and control of the project. Furthermore, there is still a debate among scientists and practitioners about the importance of studying the success factors of project (e.g. Ika et al. 2012; Mavi, and Standing, 2018). As project management success is measured using an array of different criteria, a multi-criteria decision making approach is appropriate as a method of evaluation. In reality, there are so many project management success factors it is difficult to identify the dependence relations between them.

The high-tech industries are characterized by a sustained rhythm of innovation, which is determined by dynamic and highly competitive markets and requires continuous increase of performance at the same or even reduced price. High-tech organizations often face challenges

as part of managing various types of R&D projects (Beckman, and Sinha, 2005). In R&D projects within high-tech industries, new products are designed, using not only established technologies, but also a substantial amount of new technologies. In fact, projects can include radical innovations that have revolutionary changes in technology and clear deviations from existing practices. According to several authors (e.g. Belso Martínez et al. 2013), a greater number of successful R&D projects leads to higher incomes for shareholders and higher learning for their employees. Linking innovation with project-based organizations in high-tech industries, this study demonstrates the effect of certain organizational characteristics on the success of the high-tech R&D projects.

This study uses fuzzy set Qualitative Comparative Analysis (fs/QCA), a set-theoretic approach with the ability to handle high degrees of complexity in how different causal conditions combine to bring about an outcome (Ragin, 2000, 2008). In the current research, this approach enables the study of organizational characteristics interdependently. Rather than estimating the average net effect of particular characteristics, the study assesses how multiple, alternative configurations of them explain R&D projects performance. These findings help complement some results in previous studies on R&D projects performance and shed light on the project's performance effects of selected organizational characteristics such as structural differentiation, innovation strategy, cooperation with stakeholders, project team autonomy.

The motivation for this study is twofold. First, prior literature tends to investigate the effect of the different organizational characteristics on the R&D projects performance in an isolated fashion, largely ignoring the fit between the characteristics and performance. One of the few studies on configurations of factors in relation to projects performance that could be identified through a literature review was research conducted by Dahlgren and Söderlund (2010) or Martínez, Molina-Morales, and Mas-Verdu (2013). Dahlgren and Söderlund (2010), by way of a multiple case study on four Scandinavian organizations, identified what type of projects performance is likely to be adopted under a combination of high vs. low project dependence and high vs. low project uncertainty. In turn linking innovation with project-based organizations, the study conducted by Belso Martínez, Molina-Morales, and Mas-Verdu (2013), demonstrates the effect of certain organizational characteristics in the success of innovation projects that a firm develops. The current paper builds on that research by examining how configurations of multiple organizational characteristics are related to the B&R projects performance. This constitutes the first contribution of the current paper. Secondly, studies of projects-based organizations in high-tech industries so far focus predominantly on performance management of projects or portfolios of projects but give little attention to performance management at the organization level. This study complements the earlier studies by applying organization theory to the study of project-based organizations in high-tech industries as called for recently by Miterev et al. (2017). In sum, the research question this paper answers is: What combinations of organizational characteristics are associated with the different R&D projects performance in high-tech organizations?

Following this introduction, Part 2 of this paper presents the theoretical framework, Part 3 describes the research method, Part 4 presents research findings and Part 5 contains the conclusions and discussion.

2. Theoretical background

The literature reveals a rich tradition of studies on contingency factors affecting projects performance in traditional, non projects-based organizations. The prior reviews conducted by Chenhall (2007) and Otley (2016) identify in essence the same contingency factors and include technology, strategy, organizational structure and size, and cooperation with partners, customers, and suppliers. The literature shows that there exists a lack of analysis about the impact of organizational characteristics on the performance of R&D projects. To maintain connectivity and consistency with previously derived evidence, the author of this research worked upon the studies of Chandrasekaran et al. (2015), Langfield-Smith (2006) and Ganter and Hecker (2014), Fiss (2011) regarding selection and definitions of organizational characteristics influencing the performance of R&D projects. On the basis of these considerations, the following Hypothesis was made: structural differentiation, innovation strategy, degree of cooperation with stakeholders and project team autonomy effect performance of R&D projects in a high-tech company. The section below elaborates on each of the characteristics and their association with projects performance as found in prior research.

In R&D settings, structural differentiation and ability to maintain separate reporting structures, metrics, and processes for different types of R&D projects are among the most important organizational characteristics (Chandrasekaran et al. 2012). Structural differentiation helps create the so-called pragmatic boundaries between R&D projects, helping them to coexist in the same environment (Gilbert, 2005). As indicated by research conducted by Chandrasekaran et al. (2015), project team members from innovative projects confirm that structural diversification within their business units helped them progress better in their projects. They proved that using structural differentiation based on the extent of change can be effective in managing innovation R&D projects in high-tech organizations.

The second organizational characteristic in this study captures the organizational attitude and behavior towards innovation and differentiates between explorative and exploitative innovation strategies of projects-based organizations. Explorative strategy is characterized by risk taking, search, variation, testing, discovery, flexibility and innovation in order to pursue innovations for new clients or markets (Jansen et al. 2006). On the other hand, exploitative strategy includes refinement, efficiency, selection, production, execution and implementation building on existing knowledge and needs of existing clients (Jansen et al. 2006). March (1991) argued for a fundamental trade-off between the exploration and exploitation strategies.

Distinguishing between exploration versus exploitation can have important implications for the ease of learning and, hence, the degree to which firms can build and leverage external experience for greater performance in subsequent R&D projects. Exploitation relies on making current processes and outputs more efficient though establishing routine, formalization, centralized authority, and standardized responses to environmental issues (Jansen et al., 2006). In contrast, Simons (1987) finds that high performing prospectors represent explorative strategy with radical innovations and are designed to meet the needs of emerging customers or markets. This ambiguity is in line with Langfield-Smith's (2006) literature review results. Literature strongly links exploitative and explorative innovation orientation to projects performance (Hoand, and Rothaermel, 2010; Jansen et al., 2006).

Another significant research variable under study is the cooperation with different stakeholders participating in a project as partners, customers, suppliers, etc. Stakeholders can be defined as an individual or a group of individuals, who are influenced by or able to influence a project. The strong cooperation with stakeholders is necessary for project success, since a project can be considered a temporary organization of stakeholders pursuing an aim together (Jepsen, Eskerod, 2009). In this regard, Belderbos et al. (2004) examined and demonstrated the significant impact of various types of cooperation shared in research and development for an increase in the value added per employee and the increase in sales of new products on the market. Their results show that cooperation with suppliers and partners has a significant impact on the increase of added value per employee and projects performance.

R&D projects can also benefit from different levels of team autonomy (Stewart 2006). As shown by the results of research carried out by Hoegl et al. (2004) and Lewis et al. (2002), team autonomy can benefit radical innovation projects that have higher uncertainties. According to Lewis et al. (2002), the high level of team autonomy gives teams the freedom to challenge existing ideas and solve complex problems related to product design. Increased autonomy increases the freedom of project teams to develop their own methods to achieve project objectives because they can design and implement solutions without authorization from senior management. By building trust and mutual understanding among project team members, the structure of tasks becomes more effective at higher levels of uncertainty. Consequently, high innovation projects can benefit from higher levels of team autonomy (Hoegl, et al. 2004).

According to Burton and Obel (2004, p. 18), “the fit among the patterns of relevant contextual, structural and strategic factors will yield better performance.” From this perspective, the fit of organizational characteristics namely structural differentiation, innovation strategy, explorative and exploitative strategy, degree of cooperation with stakeholders and project team autonomy can impact the R&D project performance.

3. Methods and data

To investigate the connection between combinations of contextual conditions, organizational characteristics and R&D projects performance, this paper applies fuzzy set Qualitative Comparative Analysis (fs/QSA), which is particularly suitable for comparing a small number of cases (10-40) regarding many variables (conditions) (4-7) (Rihoux, and Ragin, 2009). Fs/QCA aims to find subsets of cases within the data set that have the same causal conditions (organizational characteristics), leading to the same outcome (R&D projects performance). Fs/QCA is considered to be the most appropriate method for this study, because: (1) it enables exploration of configurations of conditions (pathways) that in conjunction lead to a particular outcome (e.g. R&D projects performance); (2) it allows for equi-finality, i.e., multiple causal pathways that lead to the same outcome of interest; (3) it differentiates between sufficient conditions (a single condition sufficient to predict an outcome), necessary conditions (a condition that must be included in every potential pathway to a given outcome); and INUS conditions (conditions that are part of one of the possible pathways to an outcome). Respectively, fs/QCA offers the unique opportunity to identify configurations of conditions, which are difficult to identify by means of other methods.

The data came from a survey of 131 R&D projects across 53 high-tech business units in Poland. Data collection took place between January 2018 and January 2019 and formed a part of a larger study investigating innovation and international issues goals in high-tech organizations. The author conducted in-house surveys in firms and face-to-face interviews with Senior Manager, Project Leader, and Project Team Members. If an interviewee could not understand or was not willing to answer certain questions during the in-house survey, the investigator gave explanations to avoid incomplete answers. The survey included questions such as decision-making styles, business unit performance, structural differentiation, strategy, and other demographics (size, R&D investments etc.). The survey instruments were pretested at the four business units and involved all 15 R&D projects described in the qualitative study. The pretest assessed three main characteristics of the survey: timing (average time for a respondent to complete the survey), clarity (are there any ambiguous measurement items and concepts in the survey?), and content validity (does each question makes sense and is it appropriate?). Precise understanding of the cases in relation to the results of the survey is crucial in fs/QCA (Rihoux, and Ragin, 2009), because it enables the researcher to develop comparative expertise, checking each case and interpreting the outcomes of the analysis. Given between-case comparison rather than within-case analysis was the aim of this research, conducting few interviews per case complemented with additional secondary data, is a common data collection strategy for QCA-studies.

All measures stem from established scales in the projects management literature. Drawing on established measurement scales is necessary as improper measurement may result in questionable findings and potentially unwarranted conclusions. R&D projects can have objectives and need to take a holistic assessment of performance (Gerwin, and Barrowman, 2002). B&R projects performance is measured using a seven-point Likert scale, which captures the success of a project relative to its objectives across the following two dimensions: adherence to schedule and adherence to budget (Chandrasekaran, et al. 2015). This performance was computed by averaging the score on these items. The project leaders were the informants to these measures. The strategy was measured using a scale that considered the degree of explorative and exploitative strategic orientation of the organization. The questionnaire used was developed by Jansen et al. (2006) and included three items on a seven-point Likert scale. The degree of cooperation with stakeholders, variable reflecting the company cooperation with other firms, partners, suppliers, and clients – stakeholders was based on the four items on a seven-point Likert scale adopted by Bourne (2005). The team autonomy measures the extent to which project teams were given control over project planning, project objectives, personnel selection, performance evaluations of the team, and task assignments. High scores indicate a high degree of team autonomy. The five items for this scale are adapted from Chandrasekaran et al. (2015).

It is important to emphasize that the final scores of cases on contingency factors and organizational characteristics, are not based only on the above items, but also significantly on in-depth interview and analysis of secondary data that have occurred and enabled validation and motivation of case scores. The case score motivations enabled relative comparison of scores between R&D projects performance, which revealed a few small inconsistencies between initial scores and motivations, e.g., same motivations for slightly distinct scores. Corresponding to the fs/QCA approach for case score validation by means of qualitative data (Rihoux and Ragin, 2009), these inconsistencies were adjusted.

The fs/QCA approach uses Boolean logic to analyze the relationships between cases (viewed as multiple combinations of different contingency factors) and the result. Therefore, fs/QCA is especially well suited for identifying different configurations leading to better performance, because the method identifies how membership of cases is applicable in causal conditions (i.e., selected organizational characteristics) is linked to membership in the outcome variable (i.e., success in R&D projects performance). Fs/QCA is conducted in several stages (Ganter, and Hecker, 2014). In the first stage, a Truth Table is developed. Secondly, the number of rows in the Truth Table is reduced. Determining the necessary conditions enables one to distinguish the cases that lead to the outcome. In opposition, cases where the outcome is not present are irrelevant, and are thus absent when testing propositions. Thirdly, after a review of the Truth Table, an algorithm that simplifies combinations and minimizes solutions is used. The cutoff value was set to 0.8, both in line with the theory (Rihoux, and Ragin, 2009), and with the distribution of consistency scores as observed in the Truth Table. This enabled

simplification of all the combinations of conditions into shorter and more parsimonious combinations of conditions (Rihoux, and Ragin, 2009). As shown in the Results section, no single condition was found to be sufficient on its own to predict an outcome, only INUS conditions that are part of sufficient pathways to a result. The next step is to analyze whether causal conditions belong to the core or to the peripheral configurations (parsimonious and intermediate solutions). The parsimonious solution involves all simplifying assumptions, regardless of whether they include easy or difficult counterfactuals. The intermediate solution involves simplifying assumptions by including easy counterfactuals. Core conditions are part of both parsimonious and intermediate solutions. Parsimonious solutions exclude peripheral conditions, which only appear in the intermediate solution.

For use of fs/QCA, the original scales first must be calibrated into set membership values (indicating the degree of membership in a set) in the range from 0 to 1. To arrive at continuous set membership values (in the range between 0 and 1), the log odds method described by Ragin (2008) is applied. As indicated in the literature (Ragin, 2008; Woodside, 2013), three anchor points were used to perform this calibration: the 5%-percentile, the median, and the 95%-percentile of a variable. The extreme points define full non-membership/full membership in a set, while the median is the crossover point indicating that a case is neither in nor out of a set (Ragin, 2008). All analyses used the fs/QCA 2.5 software package.

4. Research findings

This section presents the results from the analysis, explaining which conditions lead firms to the result (i.e., success in R&D project performance). The first step is to examine the conditions necessary for the result. A necessity test was executed to examine whether there is a single condition in all configurations to success in R&D projects performance. A condition is necessary when its consistency is above 0.9 (Ragin, 2008), which indicates the degree to which a condition is present in all cases with the same outcome. In this study no necessary conditions were found. The Fs/QCA method enables analyzing combinations of conditions (causal configurations) between structural differentiation, innovation strategy, cooperation with stakeholders and project team autonomy. By using the calibrated values (indicating degree of set membership) for organizational characteristics and for R&D projects performance, the consistency of all configurations of the organizational characteristics with a membership in the success in projects performance set was estimated. Table 1 shows each configuration's consistency and the resulting test against the consistency threshold of 0.74 (Woodside, 2013). Filled circles indicate above-threshold levels of the respective condition. Empty circles indicate below-threshold levels. Blank cells indicate ‘don't care’ conditions.

Table 1.
Configuration explaining organizational characteristics for success in R&D projects performance

Solutions	Casual conditions					Raw coverage	Unique coverage	Consistency	Solution coverage	Solution consistency
	SD	EXR IS	EXI IS	CSH	PTA					
Solution term 1	⊖	●	⊖	●		0.48	0,37	0,87	0,66	0,84
Solution term 2		●	⊖		●	0,33	0,24	0,86		
Solution term 3	●	⊖	●			0,25	0,19	0,75		

Note. Filled circles indicate above-threshold levels of the respective condition. Empty circles indicate below-threshold levels. Blank cells indicate 'don't care' conditions.SD – structural differentiation, EXR IS – explorative innovation strategy; EXI IS – exploitative innovation strategy, CSH – cooperation with stakeholders, PTA - project team autonomy.

For the interpretation of the results it is important to note that both the intermediate solution, most often used in fsQCA, and the parsimonious solution, which identifies the 'core conditions', are presented. In addition, the consistency and coverage for individual solution terms (pathways) and the overall solution (total set of pathways) are shown. Raw coverage refers to the total percentage of cases with the associated outcome that is represented by a solution term. For example, 48% of the cases that represented success in R&D projects performance are represented by solution term 1 in table 1. Unique coverage refers to the percentage of cases that is only represented by the relevant solution term and not simultaneously by another solution term, i.e. cases that fit to solution term 1 but not to solution term 2 or 3. Consistency refers to the percentage of cases of a solution term that result in the associated outcome. For example, 85% of the cases fit to solution term 1 in table 1. For the individual solution terms, the consistency of the explained result is respectively 87%, 86% and 75% while the overall solution consistency of the combinations of paths to success of B&R project performance is 84%. The overall coverage of 66% indicates that the three solution terms jointly cover 66% of the cases.

The first configurations, solution term 1 (table 1), shows that a sufficient condition for success in R&D projects performance is the combination of presence an explorative innovation strategy and a high degree of cooperation with stakeholders and absence of structural differentiation and exploitative innovation strategy. The second configuration, solution term 2 combines presence of explorative innovation strategy and high level of project team autonomy with absence of exploitative innovation strategy. The third configuration, solution term 3 indicates that presence of exploitative innovation strategy connection with structural differentiation and absence of explorative innovation strategy is associated with success in R&D projects performance. It is worth emphasizing that the explorative innovation strategy leads to success B&R projects performance when combined with the presence of a high degree

of cooperation with stakeholders (solution term 1) or with the presence of project team autonomy (solution term 2). Summarizing, all analyzed conditions to be INUS conditions for success in R&D projects performance. In other words, rather than having an individual effect, these conditions are part of sufficient configurations leading to the success in R&D projects performance.

5. Conclusions and discussion

This study aimed to answer the question what combinations of organizational characteristics contingency factors are associated with success in R&D projects performance in high-tech organizations. Results of Qualitative Comparative Analysis on 131 R&D projects across 53 high-tech business units revealed three configurations of conditions. Two configurations, namely solution term 1 and solution term 2 contained explorative innovation strategy. Organizations with explorative strategies flexibly take advantage of opportunities in the environment; have high exploration objectives of introducing new products and processes, which benefits from high levels of autonomy (Dent, 1990). Such organizations, as indicated and confirmed by research, are supported either through a high degree of cooperation with stakeholders (solution term 1) or a high level of project team autonomy (solution term 2). Both of these combinations are sufficient to achieve success in R&D projects performance. This study confirms that investing in collaboration with stakeholders can ensure the success of a project. Cooperative relationships with stakeholders have a significant effect on the growth of added value (Belderbos et al., 2004), but this cooperation should appear together with other variables such as presence an explorative innovation strategy and absence of structural differentiation. This configuration can improve firm performance through the optimal performance of firms' R&D projects, and can guide the management board towards the establishment of strategic relationships with stakeholders that meet certain criteria to ensure the operational and strategic objectives of the firm.

Moreover a high exploration objective in projects creates a complex task environment characterized by technological uncertainties and scheduling pressures (Sethi et al. 2012). Under these conditions earlier research shows that tensions can be overwhelming if the team members do not have an explicit control over task assignments, team member roles, and day-to-day objectives (Chandrasekaran et al. 2012). In these situations, higher levels of autonomy within the team help them to better navigate the development efforts and manage trade-offs between creativity and efficiency. This argument is also supported by studies on agile software development that argue for higher levels of team autonomy when managing the trade-offs between dual objectives of changing customer requirements and shorter time-to-delivery (Vidgen, and Wang, 2009).

Configuration three, solution term 3 (table 1), indicates that structural differentiation and exploitative innovation strategy to maintain their market position albeit through controlled innovation are sufficient conditions for success in R&D projects performance. This structural differentiation in combination with an exploitative strategy implies that the management does not need to be very proactive in developing radically new products, but does need to excel in delivering the products with superior customer service. These results confirm that using structural differentiation can be effective in managing innovation, R&D projects in high-tech organizations. For example, project team members working on R&D projects often enjoy the "required freedom and flexibility" when working on complex tasks as there is minimal pressure to speed up their development activities (Jansen et al. 2009a). Lack of structural differentiation in these settings may shift preference toward incremental innovation, since these projects have fast and predictable results when compared to radical innovation projects (Girotra et al. 2007). As a result, structural differentiation can have an enabling positive effect on R&D project performance conditional if properly understood.

This study examines organizational characteristics that affect R&D projects' performance. The analysis uses fs/QCA to identify combinations of causes that lead to success in R&D projects' performance for high-tech organizations in Poland. An explorative innovation strategy supported either through a high degree of cooperation with stakeholders or high levels of project team autonomy have an important effect on the success of R&D projects. Furthermore, this study also demonstrates the effect of an exploitative innovation strategy together with structural differentiation in the ultimate success of the R&D projects. The main effect of this study for practitioners is that practitioners can clearly identify the key aspects to success in launching, planning, and development of an R&D project. In the early stages of the R&D project, such a skill can help organizations choose a strategy, structure, identify partners, and determine the degree of cooperation with them and adopt the appropriate level of autonomy of project teams.

This research has certain limitations, which may create opportunities for future investigations. The analysis conducted in this paper was based on a relatively small number of cases, and the knowledge of cases was more limited than in some other case study methods. Therefore, conducting more interviews in one case can contribute to a better understanding of the success of R&D projects. The conducted research concerns only the performance of R&D projects in high-tech organizations. Research can be extended for various types of projects (consulting, engineering) for various business sectors, and even comparing the same organizations in different European regions. Furthermore cases in the research setting of this study did not vary in terms of national culture, structure or different types of business organizations. Future research is needed to investigate whether these factors (in configurations) play a role in the R&D projects performance.

While the results of this study are based on 53 cases and replication research is probably needed, it is important to emphasize the unique potential of fs/QCA as a research method. This method enables testing configurations of conditions in relation to a specific outcome (e.g. success of projects performance), in a way that is not possible by means of a linear additive approach. In cases where the interaction of the variables included in the study is mutually significant fs/QCA offers more accurate predictions of the outcome relative to the linear additive approach.

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THE THREE ASPECTS MODEL – A NEW POINT OF VIEW ON VIRTUAL PROJECT TEAMS IN THE IT INDUSTRY

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Abstract: Information technology companies often have to setup a specific virtual environment in order to develop innovative software products. Software development requires a variety of IT tools to ensure a smooth flow of information and proper organisation of tasks within the project team. The evolution of information and communication technologies has allowed virtual teams to share knowledge online, which became more preferable than traditional meetings of developers. The main objective of this article is to determine how virtual project teams are being formed and what are the key attributes of a virtual team – a conceptual Three Aspects Model of a virtual team was presented that may be used in further research. An overview of supportive project management software solutions for virtual teams has also been conducted. The research results presented in the paper indicate that various IT tools lack support in some aspects of virtual project teams.

Keywords: project management software, IT projects, Virtual Project Team, IT project management tools.

1. Introduction

The Information Technology (IT) industry has evolved from offline development methods to online work spaces. Modern IT companies develop a plethora of new products, including operating systems or individual software in form of sophisticated programs, mobile apps, video games, websites and other types of user-related services. As a result of this productive expansion, many project management methodologies and methods have been invented or adapted to meet the requirements of new development styles. Jim Highsmith indicates that Agile Project Development has revolutionised the current state of the IT industry as a result of adaptation to user requirements, variable project scopes and iterative production cycles (Highsmith, 2004). Enterprises struggle with the high increase of information flow and dynamic changes occurring on the IT market. Efficient and incremental development of software

products with the customer's involvement have become a standard technique in most cases (Papadopoulos, 2015). New product development models were updated and combined with Agile methods and techniques (Cooper, 2014). The evolution of IT networks and technological progress of hardware allowed companies to swiftly and effectively exchange knowledge within whole organisational structures, especially in the case of project teams which are responsible for new software development. Fast communication by such means as Internet or intranets and high availability of virtual supportive tools have encouraged some enterprises to launch new product development (NPD) projects in virtual environments – often referred to as online environments or online (cloud) workspaces. Such virtual environments (or workspaces) require a professional virtual team of developers (Ford, 2017) in order to successfully complete all tasks of the current project.

Reports of Standish Group indicate that only 30% of projects end successfully. Such results concern the IT industry, where projects are often cancelled as a result of insufficient funds or due to lack of human and technological resources, as well as a result of bad management and lack of knowledge about the market (Standish Group: Chaos Reports, 2004 & 2006). Other researchers suggest that the main issue of IT development lies within a lack of proper knowledge transfer in projects' team structures (Reed, Knight, 2010). Similar problems are associated with proper understanding of different cultural aspects in multi-cultural workgroups (Adenfelt, 2010). The Version One Agile report determined that the main barriers which cause IT projects to fail are the following: improper organisational culture and philosophy of development, lack of management support, lack of experience and problems with cultural transitions (13th Annual State of Agile Report, 2019). Such impediments may often derive from lack of knowledge during the selection of a proper IT tool for setting the virtual project workspace. These issues indicate that certain procedures and preparations must be carefully undertaken while creating a Virtual Project Team (VPT). Therefore, the technological layer is not the only important aspect of Virtual Project Teams.

The main objective of this article is to determine how Virtual Project Teams are being formed and to present a general overview of IT tools that may be used to support their workflow – a conceptual Three Aspects Model was presented to characterise all important attributes of an effective and skilled VPT. Empirical research was also conducted to determine whether the aforementioned popular IT tools have the capabilities and features that can support the various aspects of Virtual Project Teams. In this article, these tools are considered as pieces of virtual environment framework software. The latter can be defined as standalone tools or applications which support project management and collaboration among members of VPT.

2. Virtual Project Management, Virtual Project and Virtual Project Team

Virtual Project Management (VPM) can be defined as the ability (of a Virtual Project Team or of an enterprise or organisation) to create and configure a proper virtual collaborative workspace, including its operating principles, and the application of ICT tools, knowledge and techniques to successfully complete virtual project activities in a fixed amount of time. The term VPM is often considered as a system (Aslam, 2010) which enables virtual teams to complete a project's duties. In other scientific papers, it is defined as an effective virtual team which has appropriate competencies to execute a virtual project (Duarte, Snyder, 2001). McMahon (2001) emphasises that virtual collaboration of multiple remote locations and units may grant better productivity than traditional single location endeavours. He also introduced an eight-step plan that can be used as a roadmap to properly set up and execute a virtual project:

- High Level Virtual Project Organisation (Virtual Culture and Virtual Leadership).
- Architecture, Work Split, Tasking.
- Planning.
- Project Rules.
- Lower Level Virtual Project Organisation (Integrated Product's Teams).
- Detailed Planning.
- Test the Operation Concept of the Virtual Organisation.
- Execute.

Other scientists indicate that Virtual Project Management consists of three major areas, namely – virtual leadership, virtual communication and cyberculture (Nozari et al., 2016). A clear definition of objectives, continuous feedback, shared vision, trust, motivation, development of collaboration and knowledge sharing – all these factors have a significant impact on a virtual project's outcome (Nozari et al., 2016). Some virtually-driven projects still require traditional face-to-face meetings during selected phases of its schedule (Lebedieva, 2011). Enterprises often conduct specific stages of the project by using VPM as a result of a product's complexity. Some project tasks may also require additional computing power and distinctive software features, which are only achievable through virtual environment collaboration. Therefore, a **Virtual Project** is a collaborative effort undertaken by a virtual team which uses a specific online environment and IT technologies to perform all project activities remotely or even in the cloud without the need of any traditional meetings (Krill, Juell, 1997). Virtual projects have various benefits in comparison to the traditional approach, as virtual teams may improve decision-making activities, reduce overhead costs and reduce project scheduling (Tastoglou, Milious, 2005).

Numerous scientific papers define a **Virtual Project Team** (VPT) as a group of people who interactively cooperate to achieve a project's goal, where at least one of the team members works in a different geographical location, time zone or organisation, and as a result, all communication and decision making is performed by the use of digital means, such as online

software, e-mails, phones, video conferences, live streams and other available means (Hertel, 2015; Gibson, Cohen, 2003; Kirkman, Mathieu, 2004; Dulebohn, Hoch, 2017). There are a few conditions which have to be meet in order to form a virtual team (Cantu, 1997):

- Telecommunication or online network connections are being established between team members located in distant geographical locations.
- Collaboration is being formed by members of different organisations or various members of one organisation in order to complete specific project activities, and their headquarters are situated in remote places.
- The time involvement of a specific member in a particular project is very dynamic and differentiates according to the project's scope, goals and unique characteristics.
- Proper IT tools and virtual collaboration software are being used for project management support (Jones, et. al., 2005).

The above-mentioned elements are crucial for setting up an effective Virtual Project Team. Building potent and well-organised virtual teams is a very difficult and challenging process. Scientists have proven that different time zones, business practices and unknown cultural habits may hinder knowledge sharing and often have a negative impact on the creation of virtual teams (Dube, Pare, 2001; Kelley-Lee, Sankey, 2008). Some articles also point out that a trustworthy leadership style plays a crucial role in building successful Virtual Project Teams (Lee, 2009; Iorio, Taylor, 2015). A more detailed overview of all attributes, aspects and characteristics of Virtual Project Teams has been prepared in the next subchapter of this paper.

3. Main attributes of Virtual Project Teams – The Three Aspects Model

The stages of a virtual project's life cycle have some similarities to a traditional project's life cycle. A virtual project may be divided into the following stages (Schumacher, 2011):

1. Project initiation – definition of main goal, virtual workspace and final effect.
2. Planning – searching for experts and resources, defining all task of the project.
3. Estimation – appointment of team members and their role assessment in the virtual environment.
4. Scheduling – defining time limitations for all tasks.
5. Organising – division of responsibility and resources for all tasks.
6. Virtual Project Team Management – role of the Virtual Project Manager.
7. Controlling and monitoring of the project – checking the progress of the project in its full time scale.
8. Finalisation of the project including creation of a knowledge sharing model for future undertakings.

Each stage or phase presented above may vary in practice, as most companies use diverse approaches to virtual project management. The role of a virtual project manager is crucial to

maintain high morale in a VPT. Traditional methods of team supervision are not as effective when managing virtual teams, and virtual project managers have to find other ways to induce trust in team members. Rapid trust from the beginning of the project is commonly used as a typical solution in virtual teams to elicit more commitment (Nandhakumar, Baskerville, 2006). Virtual team leaders must ensure that all team members have a sense of identity and belonging. Developers have to feel that their work is required for further development of the product (Haines, 2014). Members of a VPT are often portrayed as role players, where the project coordinator represents the main leader of development team (Eubanks, et. al., 2016). The virtual project coordinator is usually identified as a procedural task manager (Misiolek, Heckman, 2005), lead visionary of the project (Yoo, Alavi, 2004) and scheduler who deals with task assignment duties (Majchrzak, et. al., 2006). Team leaders often have to delegate leadership functions and responsibilities to team members (Bell, Kozlowski, 2002) – in such cases, project managers have a more supportive than supervising role.

The structure of a VPT is often divided into smaller groups which consist of experts and developers assigned to specific tasks (Chen, et. al., 2008). This practice is usually used in companies which run complex virtual projects and when their headquarters are distant from each other. Members of individual VPTs may interact with one another freely and instantly (Figure 1). Virtual team developers are often empowered by companies or project leaders to self-manage their duties. This empowerment can be considered as a VPT member's authority in decision making, which grants him/her higher awareness of a greater responsibility, satisfaction in accomplishments and especially a sense of ownership. This approach may resemble a holacracy – an approach where no hierarchical structures are used in organisation, but instead all developers are self-organised and assign themselves to particular roles (Robertson, 2015).

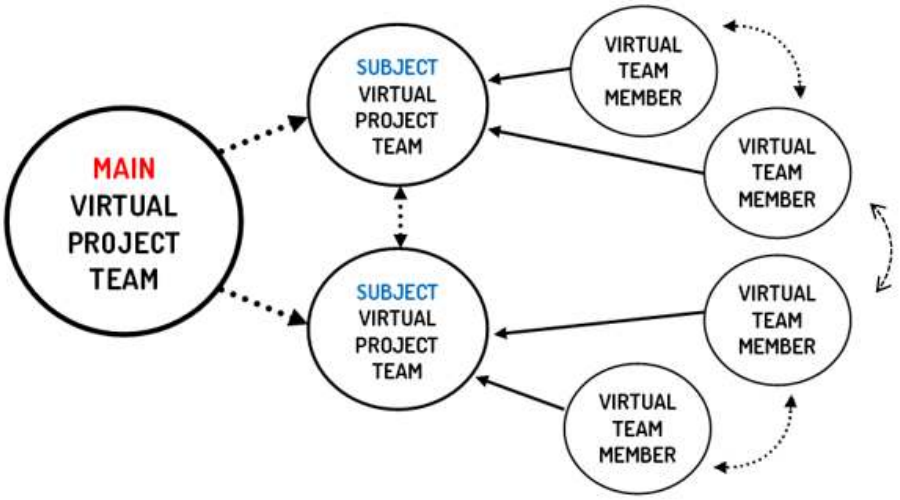

Figure 1. Network structure of a complex Virtual Project Team. Source: own work.

Building a strong VPT not only requires a group of qualified developers, proper team organisation, trust or knowledge-sharing, but also access to professional hardware. The latter is mainly used to establish a collaborative working environment. Scientists indicate that a VPT's

environments are built upon three specialised layers such as: organisation layer, virtual team management layer and resource layer, as shown in Figure 2 (Chen, et. al., 2008).

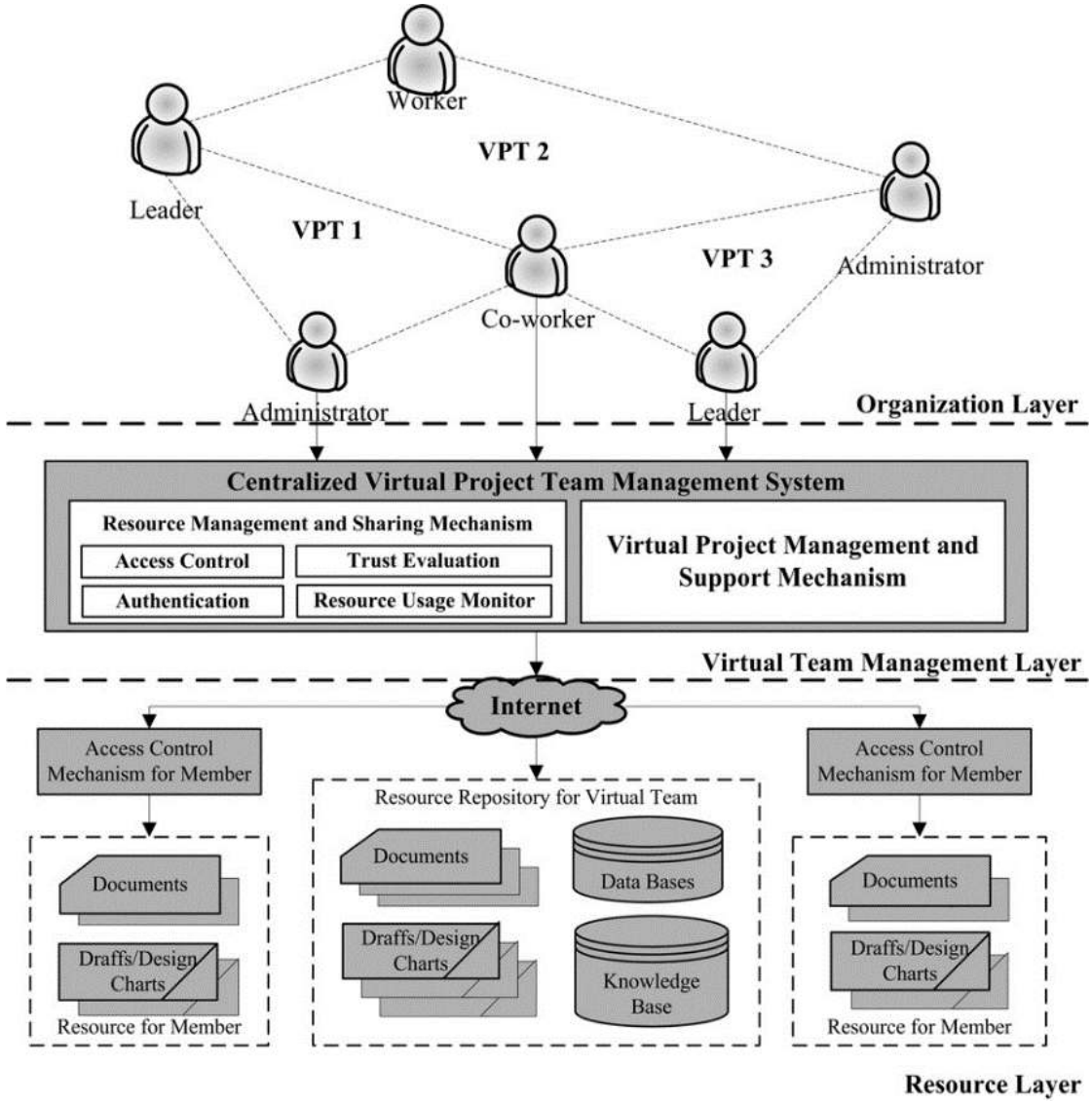

Figure 2. Structure of the Virtual Project Team Working Environment. Adapted from: Chen T., Chen Y., Chu H.: Developing a trust evaluation method between co-workers in a Virtual Project Team to enable resource sharing and collaboration. Computers in industry. Computers in Industry 59, Elsevier, 2008.

The organisation layer is defined as the overall Virtual Project Team structure, including important stakeholders and network administrators. The Virtual Team Management layer consists of Virtual Project Management and the Support Mechanism, as well as Resource Management combined with the Sharing Mechanism. Both mechanisms operate through the use of virtual environment framework software and a variety of useful IT tools. Other aspects such as trust evaluation or access control are associated with leadership style and common procedures used in a particular enterprise. Finally, the Resource layer contains virtual drives and resource management databases, which are being used for knowledge sharing and as a document

repository. Proper configuration of the resource layer may have a significant impact on the workflow of a virtual team.

People, processes and technology are considered as components of Virtual Project Teams (Conill, 2013; Olaisen, Revang, 2017). People are the key element of every VPT, and such factors like task-related communication behaviours, team integration and a set of soft skills have an important impact on the level of trust among virtual team members (Rico et al., 2009). Properly established processes organise the general workflow of the team and allow them to manage resources in a more efficient way. Technology is considered as ICT hardware, IT systems and software solutions which are mainly used to manage new product development projects, support team collaboration and store valuable knowledge in data repositories. The project management features of the aforementioned software solutions help virtual teams track various dependencies associated with projects, such as product backlog, deadlines and milestones. They also provide better control over project resources. Team collaboration features are mainly used to aid team members in establishing fast communication, asset creation and to support decision making. Such software solutions like Wrike or Monday offer special dashboards where every user can check the current status of the project, manage tasks and get an overview of all project objectives.

By combining all the aforementioned features and characteristics of a VPT, a new approach may be considered, where Virtual Project Teams can be formed on the basis of three aspects: Transparency Aspect, Technological Aspect and Social Aspect (also identified as Soft Skills Aspect). On the basis of these assumptions, a conceptual model of a VPT has been constructed – we have decided to call it the Three Aspects Model (Figure 3). The model presented below has been based on a literature review which indicated the most important factors and features of Virtual Project Teams. The essential literature that laid the groundwork for the Three Aspects Model consisted of scientific papers in which three key attributes and elements of virtual teams were identified (these attributes are often referred to as three dimensions of virtual collaboration):

- People, links, purpose (Lipnack, Stamps, 1999);
- Time, space, culture (Fisher, Fisher, 2001);
- Time, place, organisation (Kimble et al., 2000).

The above factors and characteristics were extended by the common issues and challenges of virtual teams, such as:

- Proper team organisation and setup of technologies (Munkvold, Zigurs, 2007);
- Multicultural communication and collaboration (Duran, Popescu, 2014);
- Soft skills and trust within virtual team development (Greenberg et al., 2007);
- Leadership issues (Liao, 2017);
- Problems associated with knowledge sharing (Pinjani, Palvia, 2013);
- Problems associated with communication in virtual teams (Marlow et al., 2017);
- Issues associated with optimal selection of ICT tools and IT systems (Dávideková, 2017);
- Problems associated with diversity among virtual team members (Taras et al., 2019).

All three aspects of the proposed model can be considered as maturity states pursued by evolving virtual teams. In other words, virtual team members put a lot of effort into achieving

a high level of transparency in knowledge sharing, enhance self-organisation, optimise technological tools to maximum capability and obtain a superior level of cooperation and feedback. There are other types of approaches which describe the proper establishment of virtual teams from the perspective of project management (like the one presented by Rolfes, M., 2001), but they mainly focus on certain project phases. Apart from project management, the Three Aspects Model puts more emphasis on social aspects and the collaboration level among VPT members, including technology combined with knowledge-sharing, and proposes a slightly different point of view in this matter. This model mainly concentrates on a Virtual Project Team and its attributes as a unique construct instead of focusing mainly on a Virtual Project or Virtual Project Management.

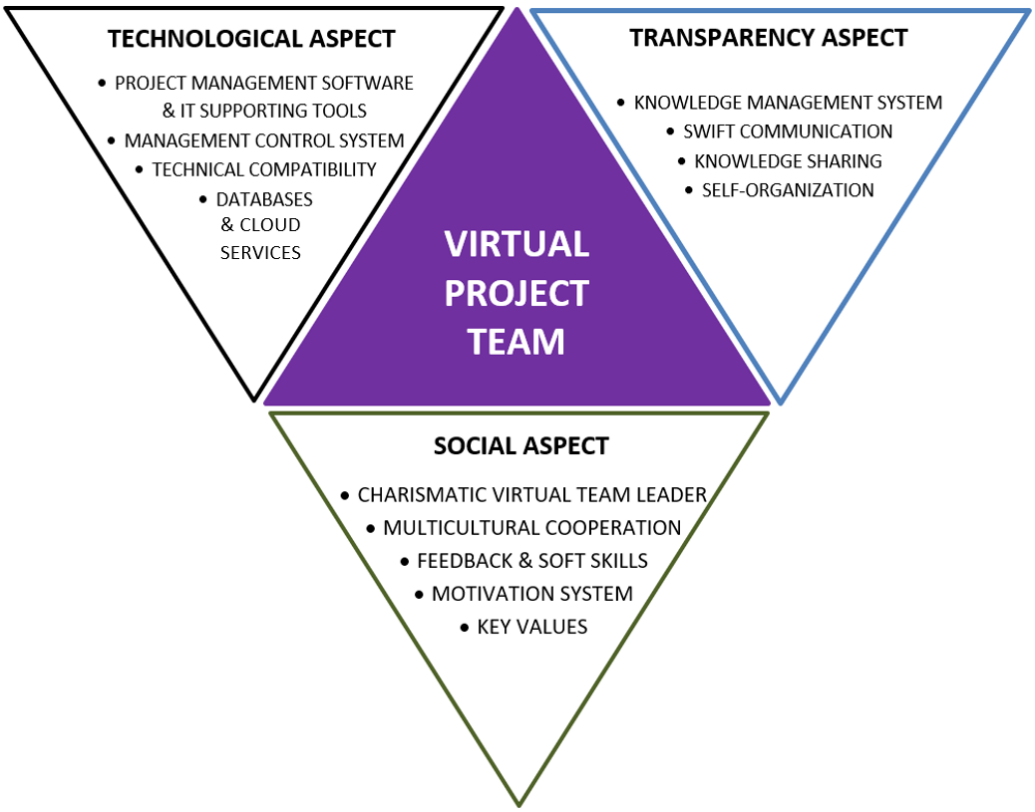

Figure 3. Conceptual Three Aspects Model of a Virtual Project Team. Source: own work.

The Transparency Aspect integrates features of knowledge sharing and access to all important enterprise data. It also includes a knowledge management system, which determines the flow of all valuable information and knowledge throughout the environment of a Virtual Project Team. Collaborative and integrated knowledge sharing is a fundamental factor for creating a successful virtual team (Olaisen, Revang, 2017; Zahedi, et. al., 2016). Interpersonal trust, knowledge transfer, efficient communication and understanding of informal knowledge sharing all have a positive impact on a virtual team's performance and on a project's progress (Navimipour, Charband, 2016). Knowledge management helps to develope collaborative activities and maintain the overall development endurance of the group (Alsharo, et. al., 2016). The SECI model of knowledge sharing plays an important role here, as ICT systems, IT software solutions and

cloud computing solutions may enhance the four modes of knowledge conversion – socialisation, externalisation, combination and internalisation (Nonaka, et. al., 2000).

The Technological Aspect consists of all IT project management supporting software solutions, team-work collaboration software solutions, video and communication software solutions, databases and file repositories, additional applications, management control systems and, most importantly, technical compatibility and network accessibility for all Virtual Project Team members (Conill, 2013; Majchrzak, et. al., 2000; Conforto, Amaral, 2016). Software solutions and IT tools may vary depending on the type of the project. Some tools offer additional features like cloud computing or social media services (Conill, 2013). Proper arrangement of an evolving virtual workspace is a critical factor required for achieving Virtual Project Team synergy (Marlow, et. al., 2016). Supporting software can help in building virtual team structures, and most importantly, it provides features that allow the team to check the current status of the project. A proper management control system is required to set order in a team's workflow. Such a system should contain a governance system which regulates all duties and rules of cooperation (Bisbe, Sivabalan, 2017). Databases and file sharing systems also have an important influence on tasks performed by VPT members.

The Social Aspect (also known as Soft Skills Aspect) combines the need for a charismatic team leader and project manager with a proper motivation system, leadership style, multicultural cooperation, key values and a variety of soft skills for the virtual team (Jarvenpaa, Leidner, 1999; Warkentin, et. al., 1997). Team feedback turns out to be effective only when team trust is high (Pennaroja, et. al., 2015). Thus, trust is one of the main key values in virtual teams (Ford, 2017). The motivation system is the most challenging aspect of virtual environments (Conill, 2013). Team leaders and project managers must understand how to motivate their co-workers in online networks and which ways of encouragement are the best to increase the commitment of VPT members. Comprehension of content and forbearance are crucial in achieving a communication balance in a virtual environment (Jarvenpaa, et. al., 2004). Soft skills also have an important role in maintaining appropriate relations with stakeholders during the realisation of a project (Pokharel, 2011).

4. Overview of Virtual Project Team collaboration software and IT tools in the perspective of the Three Aspects Model

4.1. Description of research methods

In this study, we have assessed and rated 10 different types of project management software solutions which provide support in establishing a comprehensive workspace for virtual teams. These tools were selected on the basis of top 10 virtual project management software solutions rankings made by various tech and software-related websites. The analysis presented by the G2.com site seems most interesting, as it includes hundreds of user reviews of as many as 770

pieces of software and applications supporting project management and virtual teams. The 10 most popular project management and virtual team collaboration tools were selected, recommended by many software and business services websites (available in December 2019)[1]. In order to rate all features of selected software solutions in the perspective of the Three Aspects Model, we analysed 150 reviews (available on G2.com) of every software solution. Additionally, we conducted individual tests of every project management solution and assessed the quality of its features. The main objective of the research was to rate every unique piece of software and determine whether it is able to provide additional support within particular aspects of virtual project teams, namely:

- Project management support (technological aspect) – considered as utilities and features crucial for project-related activities, like project objective management, task and backlog management, schedule management, quality management, risk management, budget management and resource management;
- Database & cloud services support (technological aspect) – considered as availability of advanced features and functions which can be used in the virtual cloud, like simultaneous work on a certain case in a virtual workspace or the possibility to temporarily use (or pay a periodic subscription fee) additional tools available in the cloud, which also concerns compatibility with various types of databases;
- Technical compatibility support (technological aspect) – considered as the possibility to use certain piece of software on every type of mobile and standalone device, which also concerns the level of integrity and compatibility with other types of software;
- Swift communication support (transparency aspect) – considered as utilities in the form of messengers, information boards and online chat systems and their integrity with other popular communication workspaces like Slack;
- Knowledge sharing support (transparency aspect) – considered as features which enhance knowledge and data sharing, e.g. in the form of solution repositories such as general guides, practical FAQ sections and other types of advice which may provide answers to unique problems;
- Feedback & soft skills support (social aspect) – considered as functions and features which may enhance the integrity of the whole team, provide easier access to send feedback or have a positive impact on conversations;
- Motivation system support (social aspect) – considered as an employee gratuity system, e.g. where every team member can be rewarded with special badges or score points for successfully completing a specific task.

The level of support of every aspect has been rated on a scale from 1 to 5, where 1 was the lowest rating (very low support) and 5 the highest possible score (very high support).

[1] There are many websites and web portals which offer an overview of virtual team collaboration tools or project management software solutions, such as: project-management.com; capterra.com; pcmag.com; proofhub.com; techradar.com; scoro.com; thedigitalprojectmanager.com; mopinion.com; g2.com. Most of these recommend similar solutions among the top 10 project management supportive software.

Table 1.
Results of empirical research – ratings of virtual project management supportive software in the perspective of VPTs & the Three Aspects Model

No	Key capabilities & functionality / IT Tools & Software	Software price (per user/ month)	Technological aspect support			Social aspect support		Transparency aspect support		Customisation and quality of User Interface (scale of 1 to 5)	Learning curve on a scale of 1 to 5 (1 – long, 5 – short)	Final score of software solution (average score)
			Database & cloud services support rating (scale of 1 to 5)	Technical compatibility support rating (scale of 1 to 5)	Project management support rating (scale of 1 to 5)	Feedback & soft skills support rating (scale of 1 to 5)	Motivation system support rating (scale of 1 to 5)	Knowledge sharing support rating (scale of 1 to 5)	Swift communication support rating (scale of 1 to 5)			
1	Trello	Free or $12.50	2 (Low)	3 (Medium)	3 (Medium)	3 (Medium)	2 (Low)	3 (Medium)	3 (Medium)	3 (Medium)	5 (Very short)	**3.0**
2	Asana	Free or 13.49 €	4 (High)	4 (High)	5 (Very high)	5 (Very high)	3 (Medium)	4 (High)	5 (Very high)	3 (Medium)	2 (Long)	**3.9**
3	Wrike	$9.80	4 (High)	4 (High)	4 (High)	4 (High)	2 (Low)	4 (High)	4 (High)	3 (Medium)	1 (Very Long)	**3.3**
4	Basecamp	$99	4 (High)	3 (Medium)	4 (High)	3 (Medium)	3 (Medium)	3 (Medium)	5 (Very high)	3 (Medium)	2 (Long)	**3.3**
5	Monday	Free trial or $29	4 (High)	4 (High)	4 (High)	4 (High)	2 (Low)	4 (High)	5 (Very high)	4 (High)	2 (Long)	**3.7**
6	Teamwork Projects	Free or $9	3 (Medium)	3 (Medium)	3 (Medium)	3 (Medium)	2 (Low)	3 (Medium)	5 (Very high)	3 (Medium)	2 (Long)	**3.0**
7	Redmine	Free	3 (Medium)	3 (Medium)	3 (Medium)	3 (Medium)	3 (Medium)	3 (Medium)	3 (Medium)	2 (Low)	2 (Long)	**2.8**
8	Citrix Podio	Free or $9	4 (High)	3 (Medium)	3 (Medium)	4 (High)	3 (Medium)	4 (High)	4 (High)	3 (Medium)	2 (Long)	**3.3**
9	Zoho Projects	12.5 €	4 (High)	4 (High)	4 (High)	3 (Medium)	3 (Medium)	3 (Medium)	4 (High)	3 (Medium)	3 (Medium)	**3.4**
10	Microsoft Project Server	$30	3 (Medium)	2 (Low)	5 (Very high)	3 (Medium)	2 (Low)	3 (Medium)	3 (Medium)	3 (Medium)	2 (Long)	**2.9**

4.2. Research results

The analysis of available project management software solution reviews was conducted in the period of November – December 2019. The research results are presented in Table 1. All reviewers were software users (not managers or supervisors) that work at small, medium and large enterprises associated with new product development activities. The level of customisation of the user interface and learning curve were also included in the overall assessment of software features, as they were indicated as important issues among user reviews. The level of learning curve was rated on a 5-level scale of 1 to 5, where a level of 1 indicates a very long learning curve, and a level of 5 depicts a very short learning curve. Important note – the software prices presented in Table 1 were available on 16.12.2019, and they are most probably subject to change.

5. Discussion

The results indicate that most types of analysed software solutions offer a comprehensive set of features which have a positive impact on Virtual Project Management and on Virtual Project Team collaboration. Each project management software solution provides support for VPT activities, at least to some extent. Despite this, there are a few aspects and areas where they fail to do so due to lack of functionality or a high level of complexity. As shown in Table 1, Monday and Asana are the most advanced, refined and polished solutions designed for virtual teams. On the other hand, Microsoft Project Server and Redmine seem to be less suited for VPTs.

In the aspect of technological support, most tools successfully provide VPTs with a decent level of integrity and project management components. Technological compatibility allows virtual team members to use various additional tools and apps (accessories like software version tracking systems, communication workspaces or resource managers). Mobile devices and tablets are supported by almost every software solution, which enables project members to track all ongoing tasks and get feedback about current issues whenever and wherever the project member is located. Only Microsoft Project Server stands out from the rest of the solutions as it does not have sophisticated applications and functions compatible with mobile devices. However, this may be due to the specific nature of the software itself. Each solution offers a wide range of project management features, including task management, Gantt charts with detailed schedules, assignments, resources management, budged management, calendars, Kanban boards, to-do lists, workflow management, project team management and some basic components for risk management and issue tracking. The latter feature is rather limited and may still require more development by software providers, as risk analysis and risk management are quite difficult to manage in a virtual environment. Some tools like Trello or Redmine offer

a bit lesser set of project management features. Database and cloud services support is at a satisfactory level in most cases. The only exception is Trello, which is a simple Kanban-style task management tool that doesn't provide any additional functions of data transferring or cloud-related services.

Social aspect support turns out to be the most problematic area, where the majority of the assessed software solutions perform poorly or at least sufficiently. In other words, almost every software solution lacks a proper motivation system. For example, a user panel with badges, experience, abilities and description of individual skillsets would be an extraordinary feature for every virtual project member. Such individual virtual project user charters could also include developer's achievements, rewards and completed challenges from the past few months or years. Moreover, this could allow for a faster exchange of human resources among various projects that require a particular set of professional skills. Zoho, Basecamp, Citrix Podio and Asana have some of the team member motivation features, but only to a small degree or with minor functionality (usually in the form of a simple list of skills, which includes the proficiency level of every skill). In the case of feedback and soft skills, there are just a few project management software solutions that can been highlighted for having more advanced feedback-related functions or attributes, such as 1 on 1 virtual meetings or built-in virtual discussion sections, namely Asana, Wrike, Monday and Citrix Podio.

Knowledge sharing and swift communication support are the most praised and well-developed aspects of every project management software solution for VPTs. Virtually every tool offers an excellent package of communication and collaboration features, such as messengers, chats, discussion boards and panels, or even audio-video call systems. Communication is swift, effective and on demand due to mobile apps and fully-fledged desktop solutions. Only Trello, Redmine and Microsoft Project Server have limited communication capabilities. Trello lacks a decent built-in chat system among users. Redmine is an open source tool which requires complicated configuration in order to achieve a transparent environment for project's team. Lastly, Microsoft Project Server lacks advanced mobile device support and collaborative features. Knowledge sharing is rather well-developed in most cases, but some reviewers pointed out that many software solutions have limited file sharing functionality. For example, sometimes users are unable to send photos or project-related graphs including important data (these issue concerns solutions with a 'Medium' rating).

Customisation and user interface are one of the main issues of every software solution. Many users complained about the confusing design of various features, buttons or panels. Some elements of dashboards and task panels are strangely resized on different platforms and a bit puzzling to beginners. Lack of personalisation and customisation is a major problem of almost every software solution. The only exception is Monday, which has some positive reviews concerning this aspect. On the other hand, the most outdated and criticised tool is Redmine, which uses an older type of visual design. All tools have an extremely high learning curve, which means that their adaptation and proper configuration is a very difficult and demanding

challenge for VPTs. Some reviewers stated that it took them weeks to fully implement a particular solution in their company (Wrike is the hardest to learn project management software solution). The only exception is Trello, which is very easy to learn. This is mainly a result of its low complexity, as it is a simple tool for managing tasks in smaller teams.

In order to summarise the results of our project management software solution overview, on the basis of the analysed data collected from 1,500 reviews (150 reviews for every software solution) and our individual tests, we have identified 10 of the most common disadvantages that applied to almost every project management tool for VPTs – these are the following:

- Lack of features associated with motivation;
- Limited feedback functionality;
- Steep learning curve and high level of complexity;
- Low or limited customisation of features;
- Low customisation of User Interface;
- Serious performance problems;
- Lack of proper integration with other applications or software types;
- Limited mobile device support;
- Limited knowledge sharing (e.g. limited file repositories);
- Unpolished project management features (Gantt chart issues or limited resources management).

6. Conclusion

In the era of agile scrum frameworks and iterative product development, a need for better organisation of workflow has emerged, especially in software development teams. Project management software solutions allow virtual NPD teams to effectively organise their product backlog and properly manage all tasks of an IT project. These tools are also becoming the main channel of communication for a project team. This article provides a general overview of supportive project management software solutions and assesses their value in the perspective of VPTs. The Three Aspects Model of a Virtual Project Team, which consists of the Transparency Aspect, Social Aspect and Technological Aspect, was used to evaluate the supportive potential of every software solution.

Research results indicate that most software solutions provide VPTs with a vast and wide range of useful features that have a positive impact on team collaboration and project management. Unfortunately, each tool has some disadvantages and lacks functionality in particular aspects of VPTs. Most software solutions are unable to properly support motivation aspects in virtual teams. Maybe a system of gratification in the form of an individual charter

with project member's achievements, rewards, badges or individual skillsets could be an interesting solution here. However, this should not be confused with an employee evaluation card - the key aspect in this case is to motivate and satisfy the team member. Another problem is the steep learning curve of every software. Complex or highly priced software solutions are difficult and discouraging to many users. Some project management features of software solutions also seem to be limited or unpolished. Finally, the lack of demanded customisation and confusing user interface are the major issues of every project management software solution.

The study presented in this article has some limitations. First of all, this research was of a qualitative nature and took into account the subjective opinions from user reviews. Secondly, company size and the experience of the user may have a significant impact on the final assessment of a particular software solution. Another limitation was the number of selected tools which support VPTs. There are literally hundreds of tools that support virtual project management, and dozens of tools could be assessed, but a detailed evaluation of all their features could be an extremely complex research process. The results presented in this paper can be considered as a pilot study that will serve as a starting point for further research on the Three Aspects Model for VPTs.

In conclusion, more research is required in this area, especially since VPTs and IT projects are a crucial part of a very dynamic and evolving industry. Future studies should verify even higher numbers of software solutions and identify more factors which may have a significant impact on VPT collaboration. The presented Three Aspects Model is also a concept – it may be modified or extended with new elements, attributes or additional factors.

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ASSUMPTIONS FOR THE CONSTRUCTION OF A PROJECT MANAGEMENT SYSTEM IN THE GÓRNOŚLĄSKO-ZAGŁĘBIOWSKA METROPOLIS

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Abstract: The article presents the assumptions for the construction of a project management system in the GZM Metropolis, which will contribute to raising the effectiveness of functioning of the Metropolitan Office. The proposed project management system will be adapted to reflect the specific character, the needs and the conditions for the functioning of the newly created organization, i.e. the GZM Metropolis.

Keywords: project management, organization efficiency, metropolis.

1. Introduction

The metropolitan union in the Silesian voivodeship was established on 1 July 2017 pursuant to an Agreement of 9 March 2017 on the Metropolitan Union in the Silesian Voivodeship. The main goal of the GZM Metropolis is to make use of the potential of member municipalities, stimulate the creativity of residents and inspire changes that will accelerate social and economic processes. This goal will be achieved, among others, through the implementation of projects and tasks with particular emphasis on the needs and problems of member municipalities, rational spatial planning, comprehensive management of sustainable development (Statute of the "Górnośląsko-Zagłębiowska Metropolis" Metropolitan Union). The tasks which are planned and implemented by the GZM requires a systematized approach taking into account the correct allocation of resources and the rational spending of funds.

The operation of the metropolis would benefit from a project management concept adapted to the needs and conditions for the functioning of the GZM. This approach will allow to correctly plan projects, implement them, and ensure their adequate monitoring and control.

In the context of these objectives, it is necessary to develop and implement a project management system. The purpose of this article is to present the assumptions for the construction of a project management system in GZM, which will contribute to raising the effectiveness of functioning of the Metropolitan Office.

A study of literature has therefore been conducted to elaborate on public management, strategic management and project management in public administration. Furthermore, based on interviews, observations and desk research carried out in the Metropolitan Office, the main factors which affect the implementation of projects were identified.

2. Establishment and functioning of the GZM

Górnośląsko-Zagłębiowska Metropolis is a metropolitan union in the Silesian Voivodeship, established on the basis of the Upper Silesian Conurbation pursuant to the provisions of the Act of 9 March 2017 on the Metropolitan Union in the Silesian Voivodeship. The Metropolis was officially launched on 1 January 2018 as a union of 41 municipalities and communes (fig. 1) comprising:

- 26 municipalities, i.e.: Bytom, Będzin, Bieruń, Chorzów, Czeladź, Dąbrowa Górnicza, Gliwice, Imielin, Katowice, Knurów, Lędziny, Łaziska Górne, Mikołów, Mysłowice, Piekary Śląskie, Pyskowice, Radzionków, Ruda Śląska, Siemianowice Śląskie, Sławków, Sosnowiec, Świętochłowice, Tarnowskie Góry, Tychy, Wojkowice, Zabrze;
- 13 rural communes, i.e.: Bobrowniki, Bojszowy, Chełm Śląski, Gierałtowice, Kobiór, Mierzęcice Ożarowice, Pilchowice, Psary, Rudziniec, Świerklaniec, Wyry, Zbrosławice;
- 2 rural municipalities: i.e. Sośniowice and Siewierz.

A metropolitan union performs the following tasks: shaping the spatial order, stimulating social and economic development within the metropolitan union, planning, coordinating, integrative abd developing public mass transit, including road, railway and other, rail transport, as well as promoting urban mobility, overseeing tasks in metropolitan passenger transit, cooperating in the routing of national and regional roads within the metropolitan union, promoting the metropolitan union and its area. Apart from these, the metropolitan union is competent in the implementation of public tasks pertaining to the scope of the municipality, poviat or voivodeship self-government, or in coordinating the implementation of these tasks pursuant to a memorandum of understanding entered into with a self-government unit or an association of self-government units (the Act of 9 March 2017 on the Metropolitan Union in the Silesian Voivodeship).

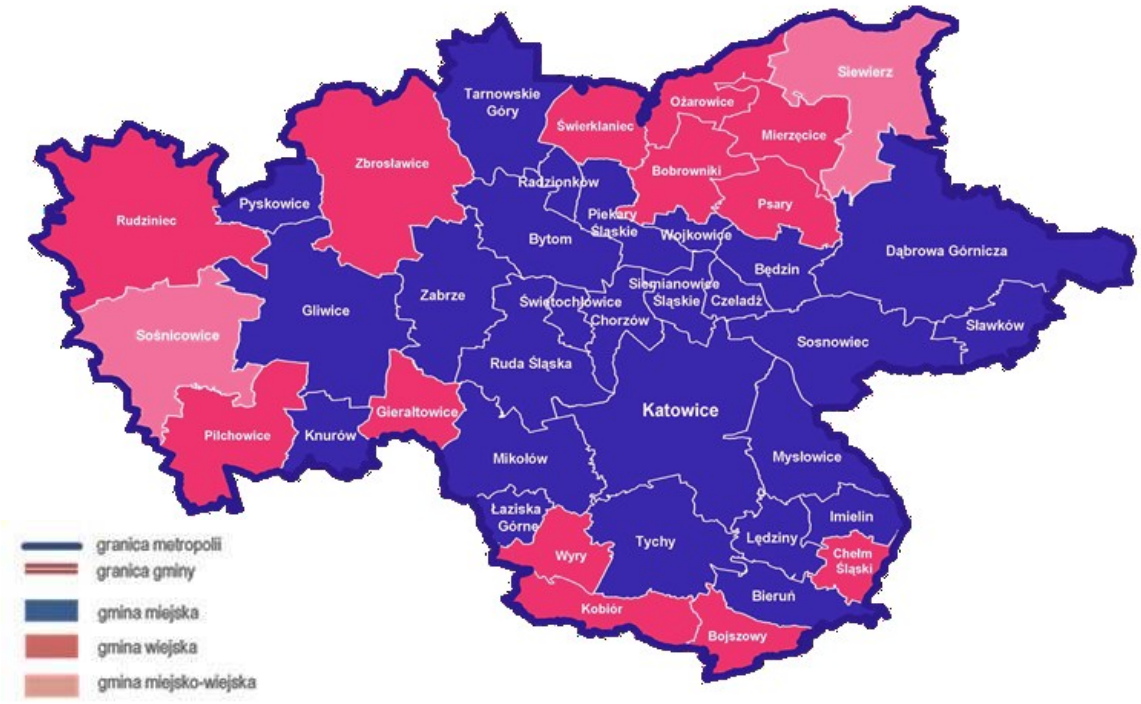

Figure 1. Members of the GZM. Source: GZM documentation.

The directions for operations implemented by the GZM are laid down in the Strategic Operations Plan for 2018-2022 approved by the Assembly[1] in November 2018 roku (http://bip.metropoliagzm.pl). The document contains a list of measures aimed to transform the members of the GZM into a modern and cohesive area, friendly to its residents.

This task is financed from the revenues generated by the GZM, which consist of: 5% of the personal income tax paid by the residents of the union, membership contributions paid by the member municipalities and communes, revenues generated by the budgetary units of the metropolitan union, and payments madde by the budgetary establishment of the metropolitan union. revenues generated by the metropolitan union; subsidies granted under the state budget, subsidies granted under local government budgets, inheritance, provisions and donations made to the metropolitan union and other funds specified otherwise.

To ensure the efficient implementation of the tasks stipulated by the act (the Act of 9 March 2017 on the Metropolitan Union in the Silesian Voivodeship), the following official bodies of the metropolitan union were established: the Assembly and the Managemenr Board of the metropolitan union. The Metropolitan Office is the organizational unit appointed to complete the tasks set by the Assembly and the Management Board. One of the primary tasks of the Office is to create adequate organizational, technical and administrative conditions to organize the work of individual bodies of the Metropolitan Union.

[1] The assembly is the executive and control body of the metropolitan union. It is formed by delegates of the municipalities comprising the association, one for each municipality. These delegates are municipality governors, mayors or city presidents, or their authorized representatives.

3. Formulation of a research problem

The goal of GZM is to make use of the potential of member municipalities, stimulate the creativity of residents and inspire changes that will accelerate social and economic processes. Thus formulated, the objective will be accomplished, among others, through the implementation of projects and tasks. The current environment of contemporary public organizations is characterized by a high level of uncertainty, complex and multi-aspect problems related to the management of relations with stakeholders. Despite this, public organizations from all over the world are expected to increase their effectiveness while providing higher-quality services for the community. This forces them to search for new methods of public management, ones that will facilitate the effective implementation of tasks in a turbulent environment. Public organizations are often judged for their effectiveness and efficiency. Efficiency is an ambiguous notion. For the purpose of this study, efficiency is understood as the institutional efficiency of the metropolitan office. This assumes efficiently working and substantively prepared clerks, correct organizational structures, correctly selected methods, procedures and operational standards, the application of effective management instruments, expected accessibility and quality of public services (Przywojska, Podgórniak-Krzykacz, 2017). The pursuit of effectiveness in public organizations is manifested by public management concepts, i.e. the concept of traditional public administration, New Public Management (NPM), New Public Governance (NPG), Neo-Weberian State (NWS). Furthermore, the efficiency of operation of public organizations can be improved by applying instruments of strategic management and a project approach.

Since the beginning of its activity, the GZM has completed many projects, among others: free commute for children and adolescents up to the age of 16, free commute for drivers on days with elevated air pollution levels, Metropolitan Transport, Metropolitan Bicycle, and others. These enterprises required significant financing and the coordination of activities from many people and institutions. Numerous interviews, extensive observations and desk research carried out at the Metropolitan Office to examine the factors which have negative impact on the effective and efficient completion of these projects have pointed to:

- The absence of procedures for the opening, planning, implementation and monitoring of projects.
- The absence of a formally appointed project manager.
- Difficulties in the integration of project participants due to their different professional experiences (experiences gained during their work in public and business organizations).
- Difficulties in communication among project participants due to the fact that individual participants use different terminologies and different elements of project management methodologies, standards and tools.

- The absence of unified project management tools.
- The absence of toole for gathering and storing knowledge knowledge derived from projects.
- Lack of access to current knowledge on the progress of individual projects.

It is therefore necessary to create an adequate approach to project management in the Metropolitan Office, in order to combine a vision of the future with the past experiences, while limiting uncertainty and risk in project implementation.

However, the efficiency of project management requires the synchronization and coordination of measures. This approach requires an ordered and homogeneous approach to project management, which is attained, among others, by implementing standards pertaining to the methodology and technique of project management.

A review of available literature has pointed to the absence of a holistic approach to the management of a public organization consisting in a metropolitan union. A study of literature (Prawelska-Skrzypek, Jałocha, 2014; Jałocha, 2014; Dolata, 2013, 2014; Jaskanis, Marczewska, Darecki, 2015) has indicated that the main problem associated with project management in public organizations in Poland is the tension between the officious, rigid structure of work in functional teams and the work of project teams. Another notable feature is the absence of units which coordinate the implementation of individual projects.

Therefore, in order to ensure the efficient operation of a management system of a public organization, the Metropolitan Office, it is necessary to develop a project management system. A project management system should ensure the effective and efficient implementation of individual projects, and therefore to ensure the efficient functioning of the organization as a whole. Some of the measurable benefits of the project-centered approach in the metropolitan office include:

- ensuring the cohesion of project objectives with the objectives of the organization,
- applying uniform project management standards and tools,
- selecting the right employees and seeing that they perfect their competences (in connection with a personal strategy),
- exchanging knowledge and experiences by applying standardized project management tools, standardized software, common training programs, etc.

4. Conditions for the construction of a project management system in GZM

In order to ensure the efficient implementation of projects, a project management system was proposed for the Metropolitan Office, one that would take into account the specific character of this organization. The documents proposed must comply with the following documents:

- Organizational Regulations of the Metropolitan Office of the Górnośląsko-Zagłębiowska Metropolis (GZM). Appendix 2 to resolution No. 127/2018 of the Management Board of Górnośląsko-Zagłębiowska Metropolis dated 28 June 2018.
- Statute of the "Górnośląsko-Zagłębiowska Metropolis" Metropolitan Union. Appendix to resolution No. V/1/2018 of the Assembly of the Górnośląsko-Zagłębiowska Metropolis of 16.02.2018.
- Act of 9 March 2017 on the Metropolitan Union in the Silesian Voivodeship, Journal of Laws of 2017, item 730.
- The Public Procurement Act of 29 January 2004, Journal of Laws of 2004, No. 19, item 177, Journal of Laws of 2017, item 1579, 2018.
- Disposition no. 43/2018 of the President of the Management Board of the Górnośląsko-Zagłębiowska Metropolis of 23 July 2018 on the adoption of regulations for the grant of public procurement, to which the provisions of the Public Procurement Act, including any annexes thereto, shall not apply.
- Other acts and regulations regulating the functioning of local government units.

In order to develop a project management system, it is therefore necessary to review any applicable good practices and methodologies in the scope of project management. Project management methodologies can be classified into two groups of methodologies and standards: classic methodologies and standards and agile methodologies and approaches. The first group of methodologies and standards includes, among others PMBoK (*Project Management Body of Knowledge*), PRINCE2 (*Projects in Controlled Environments*), PCM (*Project Cycle Management*) and IPMA (*International Project Management Association*), (Wirkus, 2013, pp. 183-208). Agile methodologies and approaches include: SCRUM, Prince2 Agile etc. Furthermore, there are industry and company methodologies developed by expert associations from specific industries, and major business organizations.

Methodologies, standards and approaches to project management and good practices facilitate project management, pointing to correct procedures, i.e. correct methods of preparing a plan for a project and correct methods of implementing it.

In an organization like the Metropolitan Office, it would be difficult to apply a different project management methodology or standard. Any project management system developed should be adapted to the specific character, condition and needs of the Metropolitan Office.

The project management system should support the planning and implementation of projects in the Metropolitan Office. The system is assumed to include:

1. A project management model.
2. The roles of individual project management participants.
3. Project management procedures.

For the GZM Metropolitan Office, the project management model should include four stages:

1. Project initiation and definition.
2. Project planning.
3. Project implementation, monitoring and control.
4. Project closure.

For each of the stages of the model, a procedure should be developed, specifying the roles and obligations of individual participants of the project management process in the Metropolitan Office. The following entities should be the primary participants of the project management process in the Metropolitan Office:

- The Management Board of GZM, which will be in charge of securing the finances for the implementation of the project.
- A Steering Committee which will be responsible for achieving the objectives of the project.
- A Project Manager, who will be authorized and obligated to conduct ongoing project management.
- A Project Team which will be in charge of implementing individual tasks as part of the project.
- A Project Office which will offer substantive-administrative services, including providing advice, tips, assistance in project management tools.
- Project Reviewt Committee, the main purpose of which will be to assess any project initiatives reported.

A procedure for initiating and defining the project should be developed as part of stage one. Initiating and defining a project assumes the search, formulation and notification of ideas in the form of project initiatives. The possibility of submitting project initiatives in the metropolitan office should be offered to a wide group of people and institutions, not only the employees of the office, but also the residents, member municipalities and other institutions and organizations based within the GZM. Any project initiatives submitted should be reviewed by an appointed body – the Project Review Committee, based on predetermined project review criteria. Based on the review of project initiatives, the Management Board of the GZM should make a decision to open selected projects, and should appoint a Project Team and a Project Manager.

At the second stage, the project planning procedure should be supplemented with two procedures which are particularly important from the point of view of the metropolitan office, i.e. project stakeholder management and project risk management. The purpose of project planning is to create a plan of all tasks to be completed, their deadlines and costs. A plan is a document which is used to run a project, measure its actual progress relative to its expectations, and is updated in progress, as successive pieces of information about the progress of project works are received. A project plan should include the following elements:

1. Justification for the implementation of the project.
2. Main and detailed objectives of the project.
3. Stakeholder management plan.
4. Communication plan.
5. Scope of the project.
6. Project schedule, including a specification of the milestones.
7. Responsibility matrix for individual tasks.
8. Project budget.
9. Risk management plan.
10. Economic analysis of the project.

At stage three, the project implementation, monitoring and control procedure should consider the possibility of introducing changes into the project. The project implementation and controlling stage cover implementation of tasks arising from the plan, and controlling of compliance with the plan to accomplish the project objectives. This stage should particularly include the following tasks:

- coordination and control of the work of the team and any subcontractors,
- acceptance of completed works,
- ongoing reporting of the progress of the project,
- ongoing coordination of the project, due to changes taking place in its implementation.

A change may appear during the control and monitoring of the project, which may be reported by any participant or stakeholder of the project (both internal and external project stakeholders).

At the last stage, the project should be closed. This stage aims at completing any tasks related to the formal closure of all measures in all areas of the project. This stage should particularly include:

- formal closure and settlement of the project,
- review of the project (financial, technical, qualitative, etc.),
- accumulation and distribution of knowledge and experiences obtained in the course of the project, particularly by drawing up a final report from the project.

In order to depict the proposed project management system for the Metropolitan Office, a process map should be developed for each stage of the project management model. They describe the temporal progress of tasks in reference to individual participants of the project management process. Due to the sheer size of the process maps, i.e. a large number of task elements and a large number of participants, it is not possible to present them in this study.

5. Summary

The development and implementation of a project management system should contribute to improving the functionality of the Metropolitan Office.

In order to improve the efficiency of this system, organizational and material changes should be introduced. As regarding organizational changes, an organizational unit, i.e. a Project Office, should be created in the Metropolitan Office. As regarding material changes, a dedicated IT tool facilitating the process of project management should be implemented.

The project management system implemented in the Metropolitan Office must be adapted to its specific nature, its needs and its operating conditions. In order to develop this system, an analysis of methodologies, standards and approaches to project management should be conducted. This will allow to select these elements from individual approaches, which will contribute the most to ensuring the efficiency of the organization.

The proposed project management system should include: the model, the roles and procedures of project management. The implementation and application of such a system in the Metropolitan Office should contribute to the effective management of each project, and to achieving its objectives in a timely manner.

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STRATEGIC ENVIRONMENTAL TYPES AND OBSTACLES TO THE ABSORPTION OF CLEAN TECHNOLOGIES – THE CASE OF POLAND

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Abstract: The adoption of a cleaner production approach to environmental protection has generated the need to identify obstacles affecting the absorption of clean technologies by enterprises with different strategic environmental types in Poland. This research analysis focuses on a sample of industrial firms representing the following industries: food, fuel and energy and chemical. Findings indicate that there are statistical differences between the types of environmental strategies related to the influence of financial and legal obstacles to the absorption of clean technologies. The study also shows that the influence of obstacles on proactive environmental strategies was found to be smaller than on strategies with a lower level of adaptation.

Keywords: strategic management, clean technologies, absorption, obstacles.

1. Introduction

Since the early 90s, evolution of firms' environmentalism from end-of-pipe technologies towards clean technologies in controlling and reducing fossil fuel emissions and potentially limiting climate change has been observed (Acemoglu et al., 2016). Many solutions that determine enterprise response to the environmental protection regulatory changes are of a technological nature. The attitude of securing enterprise compliance with the law (reactivity) is extended with an interest in expensive "clean" environmental technologies, as a sign of anticipation of changes, which leads to predicting the environmental harmfulness risk. The risk anticipation is an antecedent of results of the negative enterprise effect on the natural environment. By extending the range of voluntary activities the enterprise responses to the requirements of market and non-market stakeholders, emphasising the role of new environmental technologies that prevent the pollution generation "at source" and activating internal resources in order to meet the surrounding requirements.

Many forms of environmentally friendly behaviours of firms are viewed as innovations, and, therefore, they should be interpreted from an absorption and diffusion perspective (Darley and Beniger, 1981). An absorption is an efficient absorption (acquisition) or acceptance by the enterprise, industry and economy of an innovation emerging on the market (Kaźmierczak-Piwko and Graczyk, 2012). A diffusion is the dissemination of an innovation within a social system. The diffusion theory focuses on how quickly and to what degree a social system accepts an innovation (Driessen, and Hillebrand, 2002). The absorption of clean technologies by an enterprise is associated with numerous conditions; therefore, it is justified to identify them and their influence on strategic environmental types of Polish companies. The aim of the article is to identify and assess obstacles to the absorption of clean technologies by enterprises in groups of enterprises with different types of environmental strategies.

2. Clean technologies and corporate strategic responses to environmental issues

Technologies are a strategic resource, co-deciding the market advantage of a company. Environmental technologies are divided into two groups: integrated and additive environmental technologies (end-of-pipe technologies). Integrated environmental technologies can be subdivided into product and process integrated measures, and these require reorganisation of the whole production process in companies (Figure 1). Searching for solutions preventing the emission of pollutants (dust, gas, sewage, waste, etc.) and the implementation of integrated environmental technologies seems to be a more beneficial solution than removing the effects of generated pollution through obsolete "end-of-pipe" technologies (Rennings, 2000; Baumgartner and Zielowski, 2007). The cost of developing a company's own technology is a much more capital-intensive undertaking than the absorption of environmental technology from outside an enterprise (Teece, 1977). The absorption of new technologies means acceptance of innovations that emerge as a result of the innovations' diffusion (Leszczyńska, 2011). Lanoie et al. (2011) argue that technology-based standards often impose the best available technology that already exists, providing little incentives for investment in R&D (Lanoie et al., 2011).

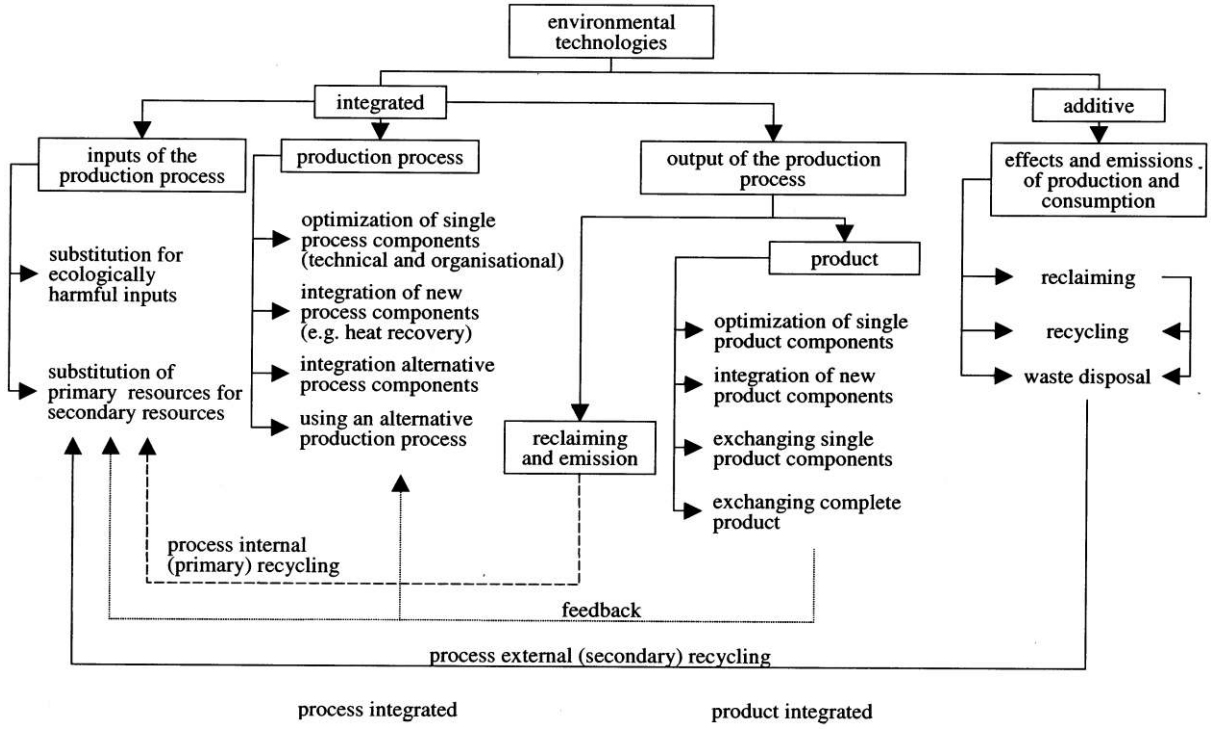

Figure 1. Preventive environmental technologies. Adapted from: Hohmeyer and Koschel (1995).

Enterprises may adopt environmental strategies from reactive to proactive ones as a result of external changes. Many solutions that determine the enterprise response to the environmental protection regulatory changes are of a technological nature. Constant monitoring of the legal requirements leads companies to explore pollution prevention options and to use clean technologies. Currently, a cleaner production approach, in other words a proactive approach, is characteristic for companies which adopt cleaner or clean technologies in products, processes and supply chains (Seroka-Stolka, 2014).

As technologies are a strategic resource, they can determine the strategic environmental types of firms. More studies present the classifications of environmental strategies based on continuum strategic possibilities. Henriques and Sadorsky (1999) consider four strategic environmental types – reactive strategy, defensive strategy, accommodative strategy and proactive strategy. Roome (1992) performs a classification of environmental strategies based on the reaction of firms to environmental management standards of the industries in which they operate. Roome (1992) also considers the passive environmental strategies of those firms that do not satisfy the minimum environmental requirements within the continuum. Reactive strategies are found at the next level of the continuum. Reactive environmental strategies represent a firms' response to compulsory environmental requirements and regulatory requirements (Murillo-Luna et al., 2008). Proactive environmental strategies are located in the most advanced positions of the continuum. These strategies are based on the use of the most advanced practices to prevent pollution, which have been defined by Sharma and Vredenburg (1998) as those strategies that go beyond the requirements specified by the regulation or by the normal practices of the sector.

In other words, when an enterprise only meets the regulatory requirements, then it is called a reactive environmental strategy, and when it voluntarily ("beyond regulation") extends them, it is recognised as a proactive environmental strategy (Dongwon, 2003; Darnall, J. Carmin, 2005; Aragón-Correa, 2007).

Garcés-Ayerbe et al. (2016) present the evolutionary model of strategies – from laggard positions with low intensity of environmental practices, to eco-innovative strategic positions characterised by high intensity of the adoption of environmental practices in different areas: production process, product, management and supply chains (Garcés-Ayerbe et al., 2016). Enterprises with proactive strategies are environmentally friendly and more eco-innovative than companies with less advanced strategies which adopt "end-of-pipe technologies". Enterprises with proactive environmental strategies voluntarily prevent pollution "at source" and use clean technologies, which goes beyond the legal requirements and environmental standards achieved by anticipating the most likely changes in the law. Anticipating the law requires early implementation, improvement or replacement of existing technology with new technology by enterprises.

Seroka-Stolka (2017) presents four different types of environmental strategies as follows: passive environmental strategy, reactive environmental strategy, attention to stakeholders strategy, proactive environmental strategy (Seroka-Stolka, 2017, pp. 236-237). This typology of environmental strategies is developed incrementally in an evolutionary process. It presents an evolutionary way to develop eco-innovations and was adopted in a research process. The initially dominant strategic attitude of securing compliance with the law is gradually extended with voluntary "beyond regulation" activities to develop clean technologies applicable in a given industry, business sector, region or country as a sign of legal regulation anticipation and meeting regulatory requirements. In summary, reactive and proactive environmental strategies of enterprises differ in the degree of minimisation of pollution and adoption of technologies "at source" to protect the natural environment.

3. Obstacles to absorption of clean technologies by enterprises

Clean technologies are regarded as the essential resource of ecological competitiveness (Buhl, 2016). Many research studies have confirmed that the adoption of clean technologies helps to protect the environment and contributes to a corporate green image or brand, as well as better performance and competitiveness of the firm (Ar, 2012). Companies that have decided to adopt or are in the process of implementing clean technologies should understand what existing obstacles and conditions may affect implementation of clean technologies. Nevertheless, there is no doubt that companies can develop their own environmental technologies that will be suitable for their production needs. However, external sources of

environmental technologies' absorption are considered as cheaper and requiring a shorter cycle of implementation, as well as lower business risk, for companies (Teece, 2003).

A general model of environmental technologies absorption presented by R. Kemp (1997) introduces technological and economic factors, as well as the environment conditions, that affect the effective acquisition and later implementation of environmental technologies by enterprises as follows:

- information channels,
- the scope and frequency of the information obtained,
- motivations for searching for information about environmental technologies.

The model also highlights the role of internal capabilities as learning capabilities. The level of the absorption of environmental technologies deepens on the information transfer system, the economic and technological nature of the technology and characteristics of the external environment (Kemp, 1997).

Scholars identify different conditions and obstacles relevant to eco-innovations as follows: environmental regulations, environmental standards (ISO 14001, EMAS), environmental R&D, environmental policy pressure, networking activities, quality/nature of industrial relations and process and induced costs, green culture, green information system (IS), infrastructure regulatory costs, absorptive capacity, stakeholders and culture, green organisational identity, corporate environmental ethics, green intellectual capital (Post, and Altman, 1994; Gluch et al., 2009; Qi et al., 2013; Chang and Chen, 2013; Chang, 2011; Chen, 2007).

However, some of the studies identify barriers and obstacles that prevent acquisition of clean technologies by enterprises with different types of environmental strategies. The first proposition of the classification of barriers, based on the strategic environmental adaptation of the firm, is the one proposed by Post and Altman. They distinguish between industry and organisational barriers. The industry barriers are as follows:

- high costs of the environmental investment,
- competitive pressures,
- regulatory constraints,
- information and technical knowledge.

High costs of the environmental investment are related to the acquisition of clean technologies to prevent pollution and implementation of Environmental Management Systems and often force firms to place priority on other types of investments in a situation when they are under high competitive pressure (Post and Altman, 1994). Post and Altman (1994) also indicate regulation restrictions and scarce flexibility in regulation compliance as barriers for changing the technological process and strategies towards cleaner production. Most of the authors emphasise that some characteristics of the command-and-control regulations promote the adoption of correction strategies rather than the prevention of pollution strategies by

implementation of clean technologies. Important obstacles are the lack of information about the potential results of absorption of clean technologies and access to technical knowledge.
The second proposition of the obstacles are organisational barriers as follows:

- employee attitudes,
- inadequate top management leadership,
- poor communication,
- past practices (Murillo-Luna et al., 2011; Shi et al., 2008).

Researchers often indicate the important barriers of clean technologies adoption as follows: organisational barriers such as employees' and top management's lack of commitment with the environment, limited training of employees, lack of organisational skills and qualification (Murillo-Luna et al., 2007; Zilahy, 2004). Moors et al. (2005) and Sandberg & Aarikka-Stenroos (2014) classified barriers of radical innovations as follows:

- economic barriers,
- systematic characteristics,
- knowledge infrastructure,
- legislative context,
- organisation and culture of the firm,
- stage of technology development (Moors et al., 2005, p. 663; Sandberg, Aarikka, Stenroos, 2014).

Moors et al. (2005) highlight that the organisational culture of the firm influences its environmental effects and preventive measurements and determines short-term thinking in production technologies (Moors et al., 2005). Furthermore, bureaucratic complexity related to legislation also represents a barrier that prevents environmental actions (Zilahy, 2004). Moors et al. (2005) point out that the availability of an extended firm-internal technology network including technical specialists is essential. Moreover, knowledge networks are necessary for the development and exchange of scientific and technical know-how about cleaner production methods. Therefore, it is justified to assess the influence of obstacles on absorption of clean technologies by enterprises with different types of environmental strategies. Hence the following hypotheses:

Hypothesis 1. *The effect of the influence related to the absorption of clean technologies by enterprises with a proactive environmental strategy is weaker in comparison to the environmental strategies of enterprises with a lower level of adaptation to the environment.*

Hypothesis 2. *There are statistical differences between types of environmental strategies related to the influence of obstacles on the absorption of clean technologies by enterprises.*

4. Research method and materials

The research was made on a total sample of 750 randomly chosen enterprises, based on the stratification criterion, from the following industries: food (40%), fuel and energy (36%), chemical (24%). Stratified sampling significantly increases the sample representativeness and reduces its error. A final sample consist of 180 firms, and the response rate is 24%.

A questionnaire survey was completed by management staff responsible for environmental management or production management. The four descriptions of environmental strategies (passive, reactive, attention to stakeholders, proactive environmental strategies) proposed by Murillo-Luna et al. (2008) and Seroka-Stolka (2017) were combined and used as an instrument to identify the types of environmental strategies. The respondents were asked to choose the most appropriate description of the environmental strategy if at least four of seven aspects listed in the questionnaire were suitable for their firms. According to literature, nine obstacles were chosen as independent variables and were measured through five-point Likert scales. The types of environmental strategies represented a dependent variable. Firms were asked to assess the obstacles, where the value 1 meant – "not at all important", and value 5 – "the most important" obstacle. To assess the influence of each of the obstacles influencing the absorption of clean technologies between the types of environmental strategies, the Kruskal-Wallis test and median test were performed. To indicate which groups of environmental strategies differ statistically, a post-hoc analysis was performed. The statistical verification of hypotheses was performed at three levels of significance: $\alpha = 0.05$, $\alpha = 0.01$, $\alpha = 0.1$. However, the maximum acceptable probability of making a type I error during the statistical verification of hypotheses was determined at $\alpha = 0.05$.

5. Results

The results of the self-classification indicate that 37% of companies chose a reactive environmental strategy, 35% of companies chose a strategy of "attention to the stakeholders", and 28% of the firms recognised a proactive environmental strategy. No company declaring the passive environmental strategy was identified. As a result, the sample consisted of three groups of firms with different environmental strategies (Figure 2).

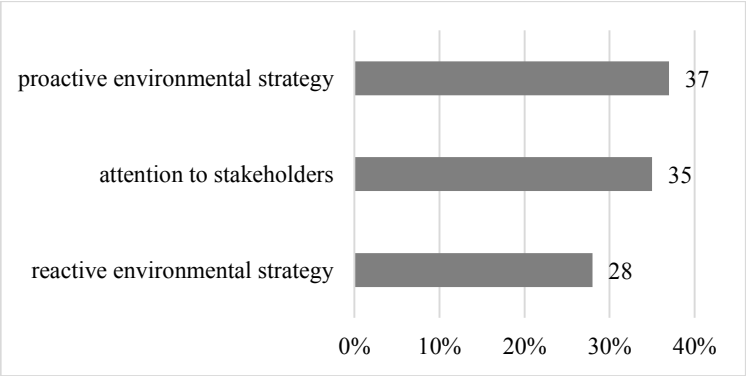

Figure 2. Types of environmental strategies in Polish companies (%). Source: own elaboration.

In order to compare three types of environmental strategies: reactive, attention to stakeholders and proactive environmental strategies, in relation to the influence of evaluated obstacles, the Kruskal-Wallis test and median test were performed (Table 1 and Table 2).

A significant effect of "limited access to external sources of financing investments in clean technologies (e.g. preferential loans, EU funds)" was confirmed both by the H test and the median test on the absorption of clean technologies between the groups of environmental strategies ($H = 10.46$, $p = 0.005$, $\chi2 = 13.48$, $p = 0.001$). A significant impact was also confirmed for the following obstacles: "lack of own funds to finance voluntary environmental investments for exchange of existing technologies for clean technologies" ($H = 10.27$, $p = 0.0059$, $\chi2 = 8.46$ $p = 0.014$), "high prices of clean technologies and services" ($H = 9.53$, $p = 0.0085$, $\chi2 = 8.50$, $p = 0.0086$) and "bureaucracy and complexity of environmental regulations" ($H = 5.70$, $p = 0.03$, $\chi2 = 5.90$ $p = 0.062$). However, the significant influence of "lack of information about the potential results of adsorption of clean technologies and environmental procedures" was confirmed by the H test ($H = 6.45$, $p = 0.039$, $\chi2 = 2.08$, $p > 0.05$), but it was not confirmed by the median test.

The results of the Kruskal-Wallis test indicate that the strength of influencing obstacles on the absorption of clean technologies by enterprises with a proactive environmental strategy proved to be significantly weaker than in the case of enterprises that adopted the strategy of attention to the stakeholders. In order to reach strategic proactivity, enterprises with a lower adaptation level have to overcome the legal requirements and financial obstacles related to the absorption of clean technologies first.

In order to assess which of the environmental strategies differ significantly in relation to the influence of obstacles on the absorption of clean technologies, post-hoc tests were performed (Table 2). Post-hoc tests revealed that differences between the types of environmental strategies are small and indistinct in relation to the influence of most obstacles. Post-hoc tests indicate that there are statistical differences between the following groups of environmental strategies:

- proactive vs. reactive strategy ($z = 2.46$, $p < 0.05$) and proactive vs. attention to stakeholders ($z = 2.35$, $p < 0.05$) for the "bureaucracy and complexity of environmental regulations",

- proactive vs. attention to stakeholders for "lack of information about the absorption of clean technologies and environmental procedures" ($z = 2.41$, $p < 0.05$),
- proactive vs. attention to stakeholders for "limited access to external sources of financing investments in clean technologies (e.g. preferential loans, EU funds)" ($z = 3.04$, $p < 0.05$),
- attention to stakeholders vs. reactive strategy for "high prices of clean technologies and services" ($z = 2.90$, $p < 0.05$),
- proactive vs. attention to stakeholders ($z = 2.580134$, $p < 0.05$) and attention to stakeholders vs. reactive strategy ($z = 2.77$, $p < 0.05$) for "lack of own funds to finance voluntary environmental investments (e.g. exchange of economically viable technologies for clean technologies)".

To sum up, the post-hoc analysis shows that there are some statistical differences between the types of environmental strategies for the influence of finical and bureaucracy and complexity of environmental regulations obstacles. The conducted research allows us to accept hypothesis 1 fully and hypothesis 2 in part.

Table 1.
Obstacles to the absorption of clean technologies. Comparing the types of environmental strategies – Kruskal-Wallis and median tests

Obstacles	A type of environmental strategy	Kruskal-Wallis test				Median test	
		Average range	Average median	H test	p-values	Chi-square test	p-value
Bureaucracy and complexity of environmental regulations	proactive	84.14	4	5.70	0.030	5.99	0.062
	attention to stakeholders	92.02					
	reactive	102.25					
High pressure from competitors in another business activity	proactive	89.20	3	0.08	0.95	1.07	0.58
	attention to stakeholders	91.85					
	reactive	89.20					
Lack of technical knowledge and information about the implementation of clean technologies	proactive	87.14	2	0.619	0.73	2.014	0.36
	attention to stakeholders	89.35					
	reactive	94.18					
Short-term planning	proactive	83.97	3	1.24	0.53	2.85	0.24
	attention to stakeholders	94.28					
	reactive	91.93					
Lack of information about the potential results of adsorption of clean technologies and environmental procedures	proactive	78.32	4	6.45	0.039	2.08	0.35
	attention to stakeholders	102.07					
	reactive	88.86					
Uncertainty of market results for the implementation of clean technologies	proactive	85.00	4	3.66	0.15	5.51	0.063
	attention to stakeholders	97.35					
	reactive	92.06					
Limited access to external sources of financing investments in clean technologies (preferential loans, EU funds)	proactive	87.77	4	10.46	0.005	13.48	0.001
	attention to stakeholders	105.42					
	reactive	75.58					
High prices (purchase) of clean technologies and services	proactive	90.05	4	9.53	0.0085	9.50	0.0086
	attention to stakeholders	112.17					
	reactive	76.45					
Lack of own funds to finance voluntary environmental investments (e.g. exchange of economically viable technologies for clean technologies)	proactive	81.67	3	10.27	0.0059	8.46	0.014
	attention to stakeholders	107.00					
	reactive	81.56					

Source: own elaboration.

Table 2.
Obstacles to the absorption of clean technologies. Differences between the types of environmental strategies – post-hoc tests

Obstacles	Differences between the types of environmental strategies	Z test	P value
Bureaucracy and complexity of environmental regulations	proactive vs. reactive strategy	2.466855	p<0.05
	proactive vs. attention to stakeholders	2.358780	p<0.05
	attention to stakeholders vs. reactive strategy	0.629729	p>0.05
High pressure from competitors in another business activity	proactive vs. reactive strategy	0.133352	p>0.05
	proactive vs. attention to stakeholders	0.138274	p>0.05
	attention to stakeholders vs. reactive strategy	0.289023	p>0.05
Lack of technical knowledge and information about	proactive vs. reactive strategy	0.225178	p>0.05
	proactive vs. attention to stakeholders	0.525691	p>0.05
	attention to stakeholders vs. reactive strategy	0.724149	p>0.05
Short-term planning	proactive vs. reactive strategy	0.819519	p>0.05
	proactive vs. attention to stakeholders	1.050975	p>0.05
	attention to stakeholders vs. reactive strategy	0.256477	p>0.05
Lack of information about the absorption of clean technologies and environmental procedures	proactive vs. reactive strategy	1.084986	p>0.05
	proactive vs. attention to stakeholders	2.419598	p<0.05
	attention to stakeholders vs. reactive strategy	1.439105	p>0.05
Uncertainty of market results for the implementation of clean technologies	proactive vs. reactive strategy	1.242284	p>0.05
	proactive vs. attention to stakeholders	1.768464	p>0.05
	attention to stakeholders vs. reactive strategy	0.576279	p>0.05
Limited access to external sources of financing investments in clean technologies (preferential loans, EU funds)	proactive vs. reactive strategy	1.254257	p>0.05
	proactive vs. attention to stakeholders	3.040337	p<0.05
	attention to stakeholders vs. reactive strategy	1.923760	p>0.05
High prices (purchase) of clean technologies and services	proactive vs. reactive strategy	1.709224	p>0.05
	proactive vs. attention to stakeholders	1.027430	p>0.05
	attention to stakeholders vs. reactive strategy	2.907927	p<0.05
Lack of own funds to finance voluntary environmental investments (e.g. exchange of economically viable technologies for clean technologies)	proactive vs. reactive strategy	0.011147	p>0.05
	proactive vs. attention to stakeholders	2.580134	p<0.05
	attention to stakeholders vs. reactive strategy	2.771021	p<0.05

Source: own elaboration.

6. Discussion

The research revealed the differences between the types of environmental strategies with respect to the influence of most analysing obstacles on the absorption of clean technologies, but financial and regulatory constraints proved to be statistically significant. Moors et al. (2005) also confirmed that the most important barriers of cleaner production technologies appear to be the cost of investment and the high risk involved in committing capital to unproven technology. The impact of bureaucracy and complexity of environmental regulations on the absorption of clean technologies significantly differs between two types of environmental strategies: proactive vs. reactive strategy and proactive vs. attention to stakeholders. Regulatory conditions have been identified as an important determinant of adopting clean technologies in several

empirical studies (Del Rio Gonzalez, 2005; Frondel et al., 2007; Long et al., 2016). Del Rio Gonzalez (2005) identified regulation pressure as one of the main drivers of adopting cleaner technologies in a survey in the Spanish pulp and paper industry (Del Rio Gonzalez, 2005). Frondel et al. (2007) highlight that the effects of environmental regulation may differ with regard to different environmental technology fields (Frondel et al., 2007). The core barrier which is identified by these studies is the financial cost of the technology or innovation placed upon the adopter. However, Frondel et al. (2004) argue that regulatory measures are not significant for the introduction of cleaner production technologies (Frondel et al. (2004). They explain that this results from the fact that cleaner production measures have been less subject to environmental regulations so far. Nevertheless, it is worth emphasising that regulatory barriers in some countries play a crucial role, because they place greater emphasis on climate mitigation. Long et al. (2016) confirm that high costs and long pay-back periods are important barriers to adoption of clean technologies. Moreover, they confirm that the diffusion process of clean technologies is still low, and the costs of the adoption of cleaner production technologies are still high (Long et al., 2016).

As a result of the study, it can also be concluded that there is a common tendency of the impact of the obstacles: the intensification of the impact of the obstacles was the largest among enterprises with strategies of attention to stakeholders and then decreased in the group of enterprises with pro-active environmental strategies. This may mean that enterprises with a strategy of attention to stakeholders first have to overcome the economic and financial constraints associated with the absorption of clean technologies to achieve strategic pro-activity. Similar research results were gained by Murillo-Luna et al. (2007) and Valero-Gil et al. (2017). They concluded that the greater the strategic proactivity level, the less influence of the barriers. Furthermore, they confirmed that major external barriers arise mainly from the high opportunity cost of environmental investment and from the bureaucratic complexity of the legislation, and these are related to their lack of financial capability (Murillo-Luna et al., 2011; Valero-Gil et al., 2017).

Access to financial resources is an important factor in the absorption of clean technologies. Limited capital leads to the creation of investment barriers. Capital remaining at the disposal of an enterprise is often shifted to priority investments. If environmental activities do not belong to them, it may be difficult or impossible to achieve more advanced environmental strategies.

7. Summary

This research study investigates the influence of obstacles related to absorption of clean technologies by enterprises with different types of environmental strategies – reactive, attention to stakeholders and proactive. The research study confirmed that financial and legal obstacles play an important role in the process of absorption of clean technologies by enterprises with different types of environmental strategies. However, further research is needed. The major limitation of the study is that the observations were collected from a single country sample. Moreover, the sample consisted mostly of big companies with proactive environmental strategies that usually have greater financial resources.

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THE PROBABILITIES OF THE TRANSITIONS BETWEEN THE INTERLOCKING DIRECTORATES' STATES BASED ON MARKOV CHAINS

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Abstract: The article analyzes the process of changes in the interlocking directorates network using Markov chains. The probabilities of company transitions between three specific states of networking, i.e. isolation, networking outside the largest component, and networking inside the largest component, were estimated. In addition, the average probabilities of transitions between states in the next 6 quarter periods, constant probabilities of transitions independent of the initial state of the process, and the expected time of return of the chain to individual states were estimated. Regardless of the initial state of networking of the enterprise, the highest probability was obtained for the process to be found in the state of connection with the largest component.

Keywords: interlocking directorates, network strategy, Markov Chain, probability of transition, estimated return time for Markov Chain.

1. Introduction

Relationships between companies may arise as a result of interlocking directorates, which Pfeffer and Salancik (2003/1978) describe as a form of interorganizational linkage that facilitates interaction between the organizations over time. This is a situation in which an inter-organizational network connection emerges. The subject of the work is related to a network of connections created through interlocking directorates, where the connection between companies is formed in a situation where at least one person is a member of the board of two companies (Mizruchi, 1996). Interlocking directorates are an important topic in organizational and management studies (Lamb, 2017). Interlocking board networks are thought to compromise the effectiveness of corporate governance (Wong, et al., 2015). Fich and Shivdasani (2006) found that corporations that have ties with other firms in interlocking board networks are associated with weak governance. Interlocking board linkages have important economic consequences for corporations and shareholders (Martin, et al., 2015; Withers, et al., 2018; Zona, et al., 2017).

The literature on the subject includes several theoretical constructions explaining the existence of interlocking directorates. They can be divided into two trends, where the subject of interlocking arises as a result of relations between directors due to personal benefits or bonds between organizations. Relationships between individuals are models of career advancement (Stokman, et al., 1988; Zajac, 1988; Perry, and Peyer, 2005), class hegemony (social cohesion) (Zeitlin, 1974; Useem, 1979, 1984; Burt, 1980; Palmer, 1983), or management control (Koenig, et al., 1979). Interorganizational relations include collusion models (Pennings, 1980; Burt, 1983), resource dependence (Pfeffer, 1972; Pennings, 1980; Pfeffer, 1987; Pfeffer, and Salancik, 2003/1978), legitimacy (Mizruchi, 1996), financial control (Dooley, 1969; Mariolis, 1975; Richardson, 1987; Mizruchi, and Stearns, 1988, 1994; Lang, and Lockhart, 1990), or reciprocity (Allen, 1974; Schoorman, et al., 1981). Each of these models can be a separate cause of interlocking at a specific time, or as a combination of several models at the same time. The strategy of establishing business connections using the board of directors is described as the most flexible and the most easily implemented (Pfeffer, and Salancik, 2003/1978), and the most widely used strategy in the area of the external environment of the company (Bazerman, and Schoorman, 1983; Yang, and Cai, 2011). This is due to a number of benefits that the interlocking directorates can bring to the enterprise (Siudak, 2018).

The enterprise at a given moment in time may be in one of three states of networking: 1) isolation, i.e. no demonstrated connections in the network (degree = 0), where the degree is the number of ties; 2) networking beyond the largest component (degree > 0 but no connection to the largest component); 3) networking within the largest component.

The aim of the article is to estimate the probability of changes between 3 specified networking states. The achievement of such a goal can contribute to the development of the theory of forming and functioning strategies based on the participation of organizations in the network. In particular, an attempt was made to answer two research questions. Firstly, is the process of the transition of enterprises between listed board interlocks stable or variable? Secondly, to which interlocking state is the organization most likely to migrate in the board interlocks network forming process? These questions identify a research gap in the literature on interlocking directorates. The aim of this paper was to fill this gap. This research is the first to show the measurement of the probabilities of the transitions between the interlocking directorates' states.

Two research methods were used in this paper. Social network analysis was employed to classify enterprises into one of the three states of networking. TheMarkov chain was used to estimate the probability of organizational transitions between the states of networking. The combination of both quantitative methods is an innovative approach in the research process.

We find that the interlocking network at the level of individual enterprises is characterized by relative variability in terms of the achieved networking state. In addition, regardless of the initial state, the company is most likely to be in a networked state within the largest component

of the interlocking network, and least likely in the state of networking outside the largest component.

The paper is organized as follows. Part 2 presents the literature review. Part 3 presents the applied research method. Part 4 describes the data underlying the study. Part 5 is devoted to the results of the study, and the work is closed with final conclusions.

2. Literature review

The theory of resource dependency (Pfeffer, and Salancik, 2003/1978) assumes that the benefits of maintaining relationships with enterprises (through joint members of the board of directors) result from the coordination of inter-organizational exchange of resources, such as capital, information, legitimization, skills and market access. The need for companies to establish relationships with other organizations arises from the desire to have access to resources controlled by those organizations (Mintz, and Schwartz, 1985). Interlocking directorates is a tool for reducing uncertainty resulting from resource dependency and information asymmetry as a consequence of obtaining low cost benefits from access to information and coordination of activities. The aim is to obtain a number of benefits for the organization in the form of increasing market information, controlling the environment, reducing dependencies, reducing transaction costs related to the relationship between the company and external entities, as an instrument to protect against the negative effects of uncertainty arising from the external environment of enterprise (Pennings, 1980; Burt, 1983; Williamson, 1984; Pearce II, and Zahra, 1992; Pfeffer, and Salancik, 2003/1978).

The demand for resources controlled by external organizations creates a dependency between the enterprise and organizations in its environment. The number of relations with external entities determines the level of resource dependency of the enterprise (Boyd, 1990, p. 419). Managing the dependency of an organization consists in acquiring and controlling key resources necessary in the activity of the organization taken to reduce dependency on other organizations and increase dependency on other undertakings (Barringer, and Harrison, 2000, p. 372). At the same time, dependence on resources may also lead to negative aspects of the organization's participation in the network in the perspective of the problem of strategic dependence on the network (Lichtarski, et al., 2017). In this context, the dependence of enterprises on resources controlled by external organizations in the enterprise environment results in a complex structure of inter-organizational relations (Kaczmarek, et al., 2014, p. 350). Empirical confirmation of the theory of resource dependence is presented in the works of: Allen (1974); Pennings (1980); Provan (1980); Boyd (1990); Dalton, et al., (1999); Chin-Huat, et al., (2003), and Sankowska and Siudak (2015).

Creating a corporate linking structure through the board of directors enables the low cost of developing a reliable information flow channel, which is an important element in the adaptation of the strategy and the process of diffusion of practices between enterprises (Mizruchi, 1992; Galaskiewicz, and Wasserman, 1989; Hallock, 1997; Wong, et al., 2015; Davis, 1991; Davis, and Greve, 1997; Chuluun, et al., 2017; Mazzola, et al., 2016; Srinivasan, et al., 2018; Rao, and Sivakumar, 1999; Chen, et al., 2009; Ortiz-de-Mandojana, et al., 2012; Yang, and Cai, 2011; Connelly, et al., 2011; Shipilov, et al., 2010; Sharopshire, 2010; Perry, and Peyer, 2005). The benefits of interlocking networking of the corporation also concern the increase in the reputation of the board of directors (Schoorman, et al., 1981), reduction of information asymmetry (Lacker, et al., 2011), transfer of tacit knowledge between enterprises (Burt, 1980; Boyd, 1990; O'Hagan, and Green 2002, 2004; Uddin, 2012; Simoni, and Caiazza, 2013), and providing access to a source of critical resources for the organization (Mizruchi, and Stearns, 1988), including the possibility of raising debt capital (Mizruchi, and Stearns, 1994). Enterprises, depending on the sources of uncertainty, may look for different benefits of interlocking. In general, the flow of information that reduces its asymmetry and the absorption and protection of external resources reducing the inter-organizational resource dependency and the associated uncertainty are recognized as the main benefits of networking companies through the members of the board of directors.

There are also disadvantages associated with networking through interlocking. Interlocking with the use of a board of directors who sit on too many other boards may lead to an excess of their duties, which is referred to as "business directors" (Harris, and Shimizu, 2004). Then, limited time possibilities result in a decrease in the efficiency of the executive monitoring function in affiliated business boards (Core, et al., 1999; Shivdasani, and Yermack 1999; Fich, and Shivdasani, 2006). The costs of networking include the loss of partial autonomy and control over the company and flexibility in making decisions (Schoorman, et al., 1981), the possibility of a conflict of interests between related companies that compete with each other for the same resources, talents of social capital, co-operators or clients (Loderer, and Peyer, 2002), diffusion of harmful management practices, costs related to remuneration and costs of the representational fund of an additionally employed board member only due to the desire of interlocking with companies on whose boards the affiliate person sits. The decision to use the strategy of interlocking should be based on the relation of the possible benefits to the costs of interlocking, where their difference is determined by the economic result from interlocking, which can be both positive and negative. Participation in the largest component of the network enables the achievement of the indicated benefits from interlocking in a much wider scope. This particularly concerns the reduction of uncertainty in the company's environment through access to more and diverse resources, and participation in the flow of information in a wider scope. The use of the interlocking strategy with the lack of connection with the largest component may be associated with the reduction of benefits while incurring similar networking costs when combined with the largest component. Then a situation may arise where the costs

of networking outweigh the benefits of interlocking. As a result, this leads to a decrease in the economic efficiency of networking. In particular, in order to create the enterprise value, the effect of acquiring resources and information from the interlocking network must be sufficiently strong, which may ensure participation in the largest component as a network of considerable size and potential benefits obtained (Siudak, 2018).

Participation in the board interlock network may have a positive impact on the financial results of the company. A positive influence of established relations in the interlock network on the return on assets (ROA) (Pombo, and Gutiérez, 2011; Lacker, et al., 2013; Horton, et al., 2012), return on equity (ROE) (Phan, et al., 2003; Pombo, and Gutiérez, 2011; Drago, et al., 2015; George, et al., 2001) and on profit has been demonstrated (O'Hagan, and Rice, 2015; Keister, 1998). At the same time, the positive impact of board interlocks on the value of the company has also been reported (Ferris, et al., 2003; Durbach, et al., 2013; Yeo, et al., 2003; Hallock, 1997). However, the effect of the created relationships in the interlocking directorates network on the value of the enterprise ignores the aspect of whether the enterprise is part of the largest component of the network or whether these relationships do not provide a link with the largest component of the network. This effect has been taken into account in the works (Siudak, 2017, 2018). Based on the analysis of variance (ANOVA), enterprises belonging to the largest network component have a significantly higher statistical market value than organizations that are outside the largest network component, but are not isolated in the network (Siudak, 2017). At the same time, it was shown on the basis of regression analysis that networking within the largest network component results in a higher market value of the enterprise (Siudak, 2018). In other words, in order to achieve a surplus of benefits over the costs of networking an undertaking, it is necessary to participate in the network within its largest component. Connection to the largest network component enables a wider range of participation in the flow of information, the possibility of acquiring resources from the organization's environment, and thus the effective reduction of uncertainty. Then, the benefits of established connections in the board interlock network will exceed the costs. Otherwise, if the company has relations in the network but is not part of its largest component, it means narrowed participation in the board interlock network and limits the possibilities of reducing uncertainty, and thus increasing the value of the company. The important issue is where the organization is in the state of networking; isolation; networking beyond the largest component; or networking within the largest component. In this context, the research questions posed in the introduction take on a significant dimension.

3. Method

The study of the interlocking directorates network can be implemented using a social network analysis. Whenever two companies share a director in the affiliation network (two-mode network), there is a link between them in the one-mode network. The board interlocking network derived from the two-mode network can be analyzed with the standard techniques of a social network analysis. The degree of a vertex is equal to the number of edges connected to it if the network is undirected, unweighted and without self-loops. Freeman (1979) indicate that degree is simple and measured by the number of direct ties involving a node in a network. In undirected and social networks there is a large component that contains more than a half of the network. The rest of network is divided into a large number of small components and isolated nodes. A component is a subset of the nodes of a network such that there exists at least one path between each vertex of that subset (Newman, 2010). Based on information about the degree and composition of the largest component, we can assign each firm to one of three states: 1) isolation; 2) outside the largest component; 3) inside the largest component.

In order to carry out the research, Markov chains were used, which are defined as processes with discrete time space. Initially, the application of Markov processes took place in physical sciences, and over time useful applications were found for economic sciences. The basic properties of Markov's processes are (Lawrence, and Pasternack, 2002, pp. CD-73):

1) The process under consideration consists of a countable number of stages.
2) At each stage the process may be in a countable number of possible states.
3) The probability of the process passing from state i in step t to state j in stage $t + 1$ is independent of the way in which the process was in state i.

Consideration will be given to the process for which we accept the process of the networking of enterprises, where, in accordance with the adopted model, may in moments $t = 0, 1, 2, \ldots, N$, occur in one of three states $S = \{1, 2, s = 3\}$. The course of the process is stochastic $(X_t, t \in N)$ and is a Markov process if variables X_t are dependent, i.e. they meet the Markov condition if the following equation is fulfilled

$$P(X_t = j | X_0 = i_0, X_1 = i_1, \ldots, X_{t-1} = i) = P(X_t = j | X_{t-1} = i) \text{ for } i, j \in S, t \in N \quad (1)$$

For particular moments $t \in N$ and for particular states $i,j \in S$, probability that the process will be in state j at moment t, provided that in moment t-1 the process was in state i, it is independent of the states in which the process was in the moments preceding moment t-1. This means that the future state of the process is independent of the state in the past. Markov processes are characterized by the lack of process memory property. Thus, the influence of the past on the future evolution of the process depends only on the observed state of the process at the last moment. The way a process is found in a certain state does not affect its future evolution (Iosifescu, et al., 2010). The estimation of the matrix of probabilities of Markov chain passages was carried out on the basis of macrodata, which is the most common in practice.

It is important to signal the originality of the research approach through the use of both research methods in one study.

4. Data

We analyzed the composition of corporate board and director networks in Poland between the end of 2015 and the end of 2016. We obtained corporate board information on the 845 companies listed in the main market at the Warsaw Stock Exchange and in the NewConnect market in the above period. These data were obtained from the Notoria database and checked for consistency. The corporate board network was constructed with 845 boards as vertices connected by an edge if they shared at least one director. The networks are undirected and unweighted.

On the basis of 845 stock exchange enterprises listed continuously during the period from the end of December 2015 to the end of December 2016, 5 networks were constructed at quarterly intervals, i.e. at the end of periods (t): 1) 12-2015; 2) 03-2016; 3) 06-2016; 4) 09-2016; 5) 12-2016. On that basis, conversions of enterprises' transitions between the specified three network states were made. The number of enterprises in individual network states is presented in Table 1. These data were obtained using NetMiner 4.4.3 Cyram (2019).

Table 1.
Number of companies in the specified networking states

Period	Isolation	Outside the largest component	Inside the largest component	Total
12-2015	247	110	488	845
03-2016	250	93	502	845
06-2015	254	106	485	845
09-2016	252	133	460	845
12-2016	257	106	482	845

Source: author's own elaboration.

It is enough to establish only one connection for the company's networking (degree = 1). The formal condition for entry into the largest component is establishing at least one relationship with the company connected to this component. Other companies included in the largest component of the network have connections in more than 1. On the basis of the mean degree for the entire network – amounting to 2.67, and 4.28 for the largest component – the assumption can be made that the entry into the largest component is provided by the first two or three connections. For companies outside the largest component and those isolated, the average degree was 0.51. If isolated companies that do not use the interlocking strategy (degree = 0) are excluded from the group of enterprises not connected to the largest component,

then the mean degree is 1.69. On the other hand, only an average of 78 companies were connected to the largest component by concluding only one relationship.

5. Results

Changes in the state of the analyzed process of enterprise networking in subsequent stages $t \in N$ are shown in table 2.

Table 2.
Number of company transitions between specified networking states

		03-2016			
	Networking states	**Isolation**	**Outside the largest component**	**Inside the largest component**	**Total**
12-2015	Isolation	232	6	9	247
	Outside the largest component	5	82	23	110
	Inside the largest component	13	5	470	488
	Total	250	93	502	845
		06-2016			
	Networking states	**Isolation**	**Outside the largest component**	**Inside the largest component**	**Total**
03-2016	Isolation	225	3	22	250
	Outside the largest component	8	78	7	93
	Inside the largest component	21	25	456	502
	Total	254	106	485	845
		09-2016			
	Networking states	**Isolation**	**Outside the largest component**	**Inside the largest component**	**Total**
06-2016	Isolation	231	10	13	254
	Outside the largest component	5	91	10	106
	Inside the largest component	16	32	437	485
	Total	252	133	460	845
		12-2016			
	Networking states	**Isolation**	**Outside the largest component**	**Inside the largest component**	**Total**
09-2016	Isolation	230	7	16	253
	Outside the largest component	5	90	38	133
	Inside the largest component	22	9	428	459
	Total	257	106	482	845

Source: author's own elaboration.

The sum of elements of individual lines means the number of enterprises in the respective process states at the beginning of a given period, and at the same time at the end of the previous period, while the sum of elements of individual columns indicates the number of companies in individual groups at the end of the analyzed period. The probabilities of transitions between individual networking states, being elements of the probability matrix (**P**) of chain transitions, are presented in Table 3.

Table 3.
Probabilities of company transitions between networking states

Networking states	Isolation	Outside the largest component	Inside the largest component	Total
Isolation	0.000	0.478	0.522	1
Outside the largest component	0.706	0.000	0.294	1
Inside the largest component	0.393	0.000	0.607	1

Source: own elaboration.

The estimated probabilities of transitions concern only the first period, and the question of determining probabilities of transitions in subsequent steps (periods) will be the subject of consideration later. Table 4 presents the mean probabilities of changes in the state of networking in the next 6 quarter periods.

Table 4.
Mean probabilities of transition between networking states for the next 6 stages

Period	Isolation	Outside the largest component	Inside the largest component
t = 1	0.366	0.159	0.474
t = 2	0.299	0.175	0.526
t = 3	0.331	0.143	0.527
t = 4	0.308	0.158	0.534
t = 5	0.322	0.147	0.531
t = 6	0.313	0.153	0.533

Source: author's own elaboration.

For each subsequent period ahead from 2016, when the latest empirical data were collected, the mean probability of an enterprise getting into one of the three networking states after a certain number of steps was estimated. For example, after 6 steps, the probability of getting into the largest component was 53.3%, and in the state of isolation it was 31.3%, regardless of the state the network was initially. For all 6 stages, the probability of getting into the largest component is greater than the likelihood of isolation. The figures below show graphically the changes in the probabilities of the process transition according to the state of isolation (Figure 1); networking outside the largest component (Figure 2); networking inside the largest component (Figure 3).

The likelihood of reaching the state of the enterprise networking state in the largest component is increased in relation to the passing of time, especially in the period of one year (Figure 5). The reason for this may lie in the possibility of achieving surplus benefits over the costs of networking as a result of the relational strategy.

Isolation of the enterprise from the interlocking directorates results in the lack of receiving the expected benefits from networking, and the costs of networking are not incurred. The economic result of interlocking, which is defined as the difference between the benefits and the costs of networking, is 0. On the other hand, reaching the state of networking outside the largest component can lead to excess costs over benefits from networking. This may explain the reason for the decrease in the probability of reaching the state of isolation and networking beyond the largest component over a period of 7-8 quarters.

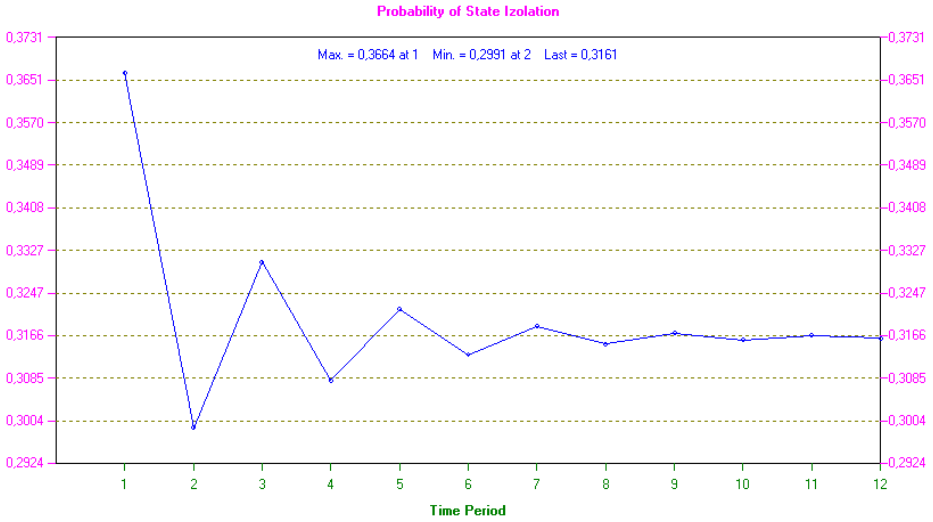

Figure 1. The probability of the chain passing to the state of isolation in relation to time. Source: author's own elaboration.

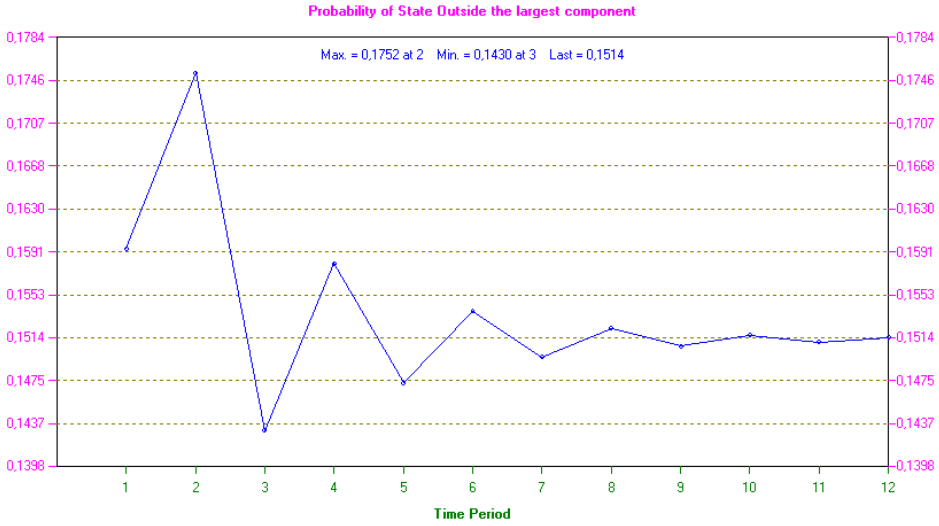

Figure 2. Probability of the chain passing to the state beyond the largest component in relation to time. Source: author's own elaboration.

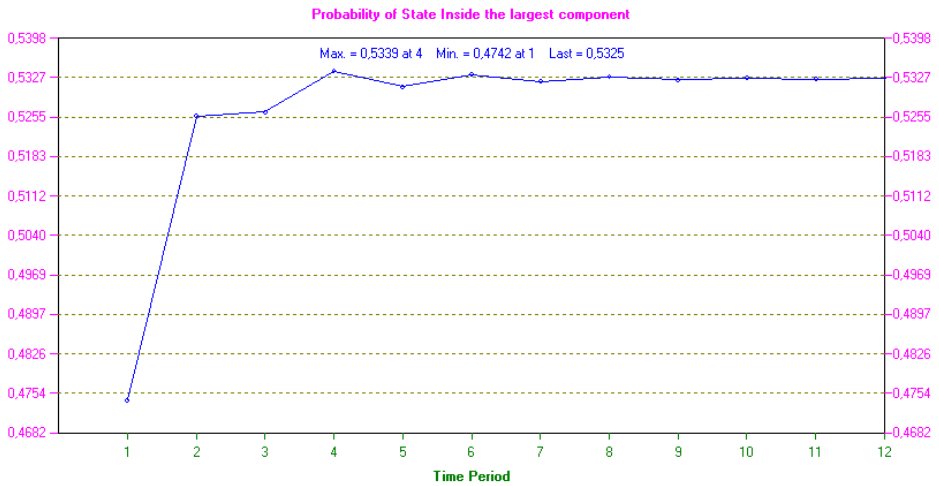

Figure 3. Probability of the chain passing to the state of the largest component in relation to time. Source: author's own elaboration.

Because the determined probability matrix of **P** transitions (see Table 2) of a finite homogeneous Markov chain is non-degradable and non-cyclical, the **P** matrix is a regular matrix and the chain is ergodic. For the appropriate number of steps (*t*), which is a suitable passage of time, the probability of the process reaching individual states is equal to the corresponding elements of the stationary boundary vector **e**, independent of the initial state of the process

$$\mathbf{e} = [0.316\ 0.151\ 0.533]$$

Since the boundary vector **e** > 0, the matrix of probabilities **P** is non-reducible, and in consequence, after a sufficiently long elapse of time each enterprise may be in one of the three networking statuses.

Because the chain in question is ergodic, the probability of passing the process to individual networking states is independent of the initial state. The ergodic limit matrix has the form of

$$lim \underset{t\to\infty}{P^t} = \boldsymbol{E} = \begin{bmatrix} 0.316 & 0.151 & 0.533 \\ 0.316 & 0.151 & 0.533 \\ 0.316 & 0.151 & 0.533 \end{bmatrix}$$

Irrespective of the initial state of networking in which an enterprise is currently located, the probability of long-term isolation in the networking is less than 31.6%; inside the largest component, 53.3%, while in the state outside the largest component – 15.1%. At the same time, it indicates that considering the large set of enterprises in the longer term, it can be stated that in the above proportions the company spends time in individual networking (32% of the time in isolation, 53% in the largest component and 15% outside the largest component). The level of constant probability of transition to states 1) isolation; 2) network connections outside the largest component and 3) within the largest component is achieved in quarter, respectively: 9, 10, 6 (from 1.5 to 2.5 years).

For the ergodic and non-reducible Markov chain, we can determine the expected time of the chain return from the state exit *i* to its first return to state *i*. This time determines the expected number of steps. If at a certain point the Markov chain stays in state *i*, then at the next moment of time (here the time is discreet) it can either remain in state *i*, which means that the process has returned to this state in one step, or go to another state. Since the ergodic matrix of transitions is regular and all states belong to the class of significant communicating states (no zeros for elements e_i of the border vector e), there is a finite time (number of steps) after which the chain will return to the initial state, *i*. Table 5 shows the expected return time chain for individual networking.

Table 5.
Expected time of return of the Markov chain to individual enterprise networking statuses

Networking states	Expected time of return [quarter]
Isolation	3.16
Outside the largest component	6.61
Inside the largest component	1.88

Source: author's own elaboration.

The expected times of returning of a process to a specific networking state concern the period that elapses from the exit of an enterprise from a given state until it returns to the same state. The expected time of returning the company to the state of networking in the largest component is 1.88 quarters (approximately 24.5 weeks). If the company loses the link guaranteeing connection with the largest component, the expected return to the largest component is less than 25 weeks. However, the return to the state of networking outside the largest component is 6.6 quarters. In other words, the state of networking beyond the largest component is a kind of transitional state. If the company makes a link allowing for connection with the largest component or goes into a state of isolation, it will take over 1.5 years to return to the networking beyond the component. On the other hand, the expected time of returning of the process to the isolation condition occurs after 3.2 quarters. This may prove relatively difficult to maintain in the long-term connection in the interlocking network.

6. Conclusions

In this study we estimate the probability of changes between 3 specified networking states. The probability of passing the process to specified networking states is independent of the initial state. With regard to the first research question, it should be stated that the interlocking network at the level of individual enterprises is characterized by relative volatility in terms of the achieved state of networking. Isolation of the enterprise is to some extent the result of the enterprise's decision. However, a networked company may lose its connection with the largest component as a result of breaking the direct link (it concerns the so-called pendant nodes) or following the break of the indirect connection. In the first case, as a result, the company most often changes the state of networking connection from the connection to the largest component of the network to the state of isolation. In the second case, the company remains networked but located outside the largest component. The mechanism of changing the networking process works similarly in the opposite direction. On the other hand, the change in the state of networking between isolation and networking beyond the largest component results from a change in purely direct relationships. The protection against changing the state of networking with the connection to the largest component of the network to the other two is the pursuit of an appropriate networking strategy consisting in maintaining one relationship with a strongly networked company, the so-called hub, or maintaining more connections with the less centrally compliant companies included in the largest network component. Then, the loss of one link does not change the state of networking. The structure of the network in terms of the number of companies in isolation and networking in the largest network component is relatively stable, especially for two opposing states – isolation and networking within the largest component. However, at the level of individual network actors, the dynamics of the networking process in

time is relatively high. In the long-term, each company, irrespective of the current state of the process, may be in one of the three networking states.

In relation to the second research question, the research conducted allows us to conclude that the organization has the highest probability of transition to a state of networking within the largest component of the network. The growing probability of being in a networked state within the largest network component (see Figure 3), the highest constant probability of being in this state regardless of the initial state and the shortest time of chain return to this state (see Table 4) shows the possibility of achieving a surplus of benefits over the costs of networking and, consequently, obtaining economic benefits from the use of a networking strategy.

This study contributes to the social network literature. The high constant probability of transition to the state of networking in the structure of the largest network component indicates the importance of conducting the organization's relational strategy. The organization's relational strategy displaces the atomic form of perception of the enterprise's activity. Participation in the board interlock network may be associated with receiving benefits in excess of the costs of maintaining relations in the network. As a result, an enterprise, by participating in the network exchange of information and potential exchange of resources with other organizations, may improve financial results and increase market value. On the other hand, competition in the demand for external resources may lead to changes in the state of the company's networking in the interlocking network.

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HUMAN CAPITAL OF TERTIARY GRADUATES IN THE CONTEXT OF THEIR EMPLOYABILITY IN THE LABOUR MARKET OF LUBELSKIE PROVINCE

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Abstract: When enrolling at university, student candidates assume that by the time they graduate, they will have acquired competencies that significantly improve their future employability. It is therefore worth verifying whether the human capital developed by students in the course of their studies really does facilitate better employment. The aim of the article is to identify the key elements of the human capital of tertiary graduates in the context of their employability. The analysis will utilise data collected in the course of a study conducted in 2017 by the provincial Labour Office in Lublin and covering 1,375 cases of Lublin university graduates residing and employed within Lubelskie province. The respondents indicated human capital elements such as education, experience, skills, and personal attributes as those that significantly influenced their employability. The study revealed that the greatest barrier to good employment is the lack or insufficiency of professional experience. In turn, the greatest advantages, significant in terms of professional activity, include the following personal and practical skills: diligence and accuracy, self-reliance, work organisation, communication skills, resilience to stress, and engagement. The respondents also mentioned the importance of availability and readiness to improve the already possessed qualifications.

Keywords: human capital, employability, labour market, tertiary education.

1. Introduction

The significance of competencies possessed in the context of labour market success has been on a steady increase in recent years (Marszałek, 2012). This is evidenced by the fact that an individual's human capital now determines the competitive edge they may or may not enjoy when seeking employment. Furthermore, human capital is recognized as the greatest source of value for companies (Sienkiewicz, 2013; Ciekanowski, 2014). Hence, it can be concluded that both individual professional careers and organisational success are to a considerable extent dependent on the attributes and abilities of people.

People enrolling at universities do so in the hope of developing their human capital by gaining knowledge, skills and experience that will later facilitate their employability. The process of developing employability is contributed to by three types of agents: universities, employers, and students – the soon-to-be graduates. One can observe certain structural inconsistencies in this context that are natural for developing economies undergoing structural reforms (Rutkowki, 2008). One should point out two key factors limiting the employability of university graduates. Firstly, there is a discrepancy between the supply of graduates and the job market demand (Balcerowicz-Szkutnik, et al., 2017). The Polish market is characterised by an over-representation of tertiary graduates relative to the available compatible employment opportunities in the market (Wronowska, 2015). Secondly, there is a discrepancy between the expectations regarding the qualifications and competencies of university graduates as reported by employers, relative to those actually gained in the course of tertiary education (Macioł, 2012).

Employability is dependent on a variety of factors, chief among which is human capital. A question therefore arises as to the degree to which university education actually improves the graduates' human capital vis-à-vis the demands of the labour market. The aim of this article is to identify elements of tertiary graduates' human capital important in the context of their employability, on the basis of which recommendations for universities can be proposed with regard to those human capital elements that ought to be developed in the course of tertiary education in order to improve the employability of future university graduates.

2. Human capital

The interest in human capital has continued to grow since the 1960s, when G.B. Becker, J. Mincera, and T.W. Schultz first introduced the concept into economic deliberations as a factor affecting production (Wieczorek-Szymańska, 2010; Potelienė, and Tamašauskienė, 2014). Human capital theory was focused on the role of education and training in the labour market. The main idea was to assume that individuals make investments in education and training in order to gain a set of skills that may be valuable for employers. That means education and training improve productivity and finally individuals' earnings. The authors of human capital theory indicated the need for investment in all types and levels of education, including university (Suleman, 2017). The idea that investment in education has extended economic and social profits for the individual and society was known much earlier. Adam Smith (2007) was the first to ascertain individual skills, abilities, and personal knowledge as valuable qualities of people in relation to their economic activities (Potelienė, and Tamašauskienė, 2014).

In Poland, similarly to other eastern and central European countries, the concept of human capital was first introduced only after the collapse of communism, i.e. at the turn of the 1990s. (Szopik-Depczyńska, and Korzeniewicz, 2011).

The literature provides numerous definitions attempting to specify the exact nature of human capital. They focus primarily on the attributes and qualities displayed by an individual. Additionally, the age and sex of the employee are also considered as factors (Rakowska et. al., 2018).

Becker (1964) defined human capital as the stock of knowledge, skills and abilities contained in an individual from natural endowment and subsequent investment in education, training and experience. Potelienė and Tamašauskienė (2014, p. 43) considered that human capital is "the ability of an individual to generate income by having a certain skillset or knowledge, or as the knowledge, skills, and experience of people that make them economically productive".

Pocztowski (2008, p. 41) understands human capital as "the overall set of attributes and characteristics embodied by people (knowledge, skills, abilities, health, motivation, values) that have an intrinsic value and constitute a potential source of income for both the employee-owner of the human capital, and the organisation taking advantage of the same under certain circumstances". Król (2006, p. 97) offers a similar definition of human capital, namely as "the sum total of particular attributes and qualities embodied by an employee which possess a certain value and constitute the source of future income for both the employee – owner of the human capital and the organisation that takes advantage of the same under certain circumstances". Both authors emphasise the fact that an individual is the owner of the human capital, which possesses a specific value and can be beneficial to both the owner and the organisation.

In turn, Blaug (1995) emphasises the dynamic character of human capital, meaning that it is not constant, its value can fluctuate, and therefore it needs to be constantly developed. The author understands human capital as "a resource of knowledge and skills with a certain inherent value that provides the basis for future income or satisfaction, a fully renewable and continuously developed human potential" (Blaug, 1995, p. 303).

Higher education is a basic form of investment in the development of human capital. Higher education can be considered as a high level or a specialized form of human capital, above and beyond the contribution to economic development, which is extremely important. Education brings very important benefits for individuals as well as society. It has a crucial impact on earnings and labour market outcomes. Investment in education also provides non-monetary profits, for example, it improves the quality of life (Potelienė, and Tamašauskienė, 2014).

The private return from education is a fundamental incentive for individuals to invest in their higher education. This indicator expresses revenues as a percentage return on the investment. The private return from education pertains only to individual investments in post

compulsory education; the indicator ignores government expenditure (Potelienė, and Tamašauskienė, 2014).

It turns out that the level of the private return from education is different for individual countries. Potelienė, and Tamašauskienė (2014), based on OECD data from 2009, calculated that of 22 European countries, the highest indicators of the returns on investment in human capital are in Poland, Hungary, Estonia and the Slovak Republic. This means that investment in education is very effective in these countries. Additionally, based on data from Eurostat from 2010, researchers showed that the average indicated wage for people with higher education in Poland is 66.2% higher than that of individuals who have acquired only secondary education.

3. Employability

The problem of employability has been discussed since the early 20th c., and the concept has evolved considerably over that period. Currently, employability tends to be approached holistically by taking into consideration various internal and external factors related to the given person, as well as any relationships occurring between said factors (Wojdyło-Preisner, 2012; Wiśniewska, 2015). Additionally, employability could be considered from three perspectives: as the national workforce level, the human resource management level, and the individual level (Rothwell et. al., 2009; Pouratashi, 2019). Consequently, the literature fails to provide a single, universally accepted definition of employability (McQuaid, and Lindsay, 2005; Harvey, 2001).

One concise definition was proposed by Pool and Swell (2007, p. 279), who understand employability as "Having a set of skills, knowledge and personal attributes that make a person more likely to secure, and be successful in their chosen occupation". Therefore, the authors emphasise the ability to display the specific human capital in the context of working in a given profession. In turn, Hillage and Pollard (1998, p. 2) posit that "For the individual, employability depends on the knowledge, skills and attitudes they possess, the way they use those assets and present them to employers and the context (e.g. personal circumstances and labour market environment) within which they seek work". They therefore observe that the value of given human capital depends on the ability to evidence the same as well as a variety of external factors.

In terms of tertiary graduates, one should also consider the definition proposed by Yorke and Knight (2006, p. 3), according to which employability refers to "a set of achievements – skills, understandings and personal attributes – that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy". An even broader definition was provided in the Council conclusions of 11 May 2012 on the employability of graduates from education and training, which state that "employability — that is, the combination of factors which enable

individuals to progress towards or enter employment, to stay in employment and to progress during their career — is a complex concept, involving not only each individual's characteristics, skills, attitudes and motivation, but also other external factors which lie beyond the scope of education and training policy, such as labour market regulations, demography, the structure of the economy and the overall economic situation".

The term "perceived employability", which is conceptualized as "individuals' evaluations of their employment chances in both the internal (i.e. within the current organization) and external labour market (i.e. beyond the boundaries of the current organization)" should be noted (Houben et. al., 2019, p. 2).

To recapitulate the afore-mentioned definitions of employability, it can be observed that its key element is constituted by human capital, whose level determines one's ability to find and maintain employment in the context of given external factors.

4. Research into the employability of tertiary graduates

In recent years the policy debate which refers to the relationships between higher education and the labour market has focused on the need to foster graduates' employability. Pressures are put on higher education to equip future employees with the right skills for economic and labour market imperatives. According to Suleman (2017), the employability of graduates for this reason is becoming a new institutional mission of higher education.

The number of tertiary graduates is increasing in the European Union. Speaking of the employability of graduates, it should be noted that the Europe 2020 strategy (2010) assumed the growth of the population aged 30-34 having completed tertiary education from 31% to at least 40%. Based on data from Eurostat from 2018, it can be concluded that the average quantity of graduates in the European Union was 40.7%, and 18 of the Member States had figures above this average. It should be noted that the highest average of tertiary graduates aged between 30-34 were in Lithuania, Cyprus, Ireland and Luxemburg (Figure 1).

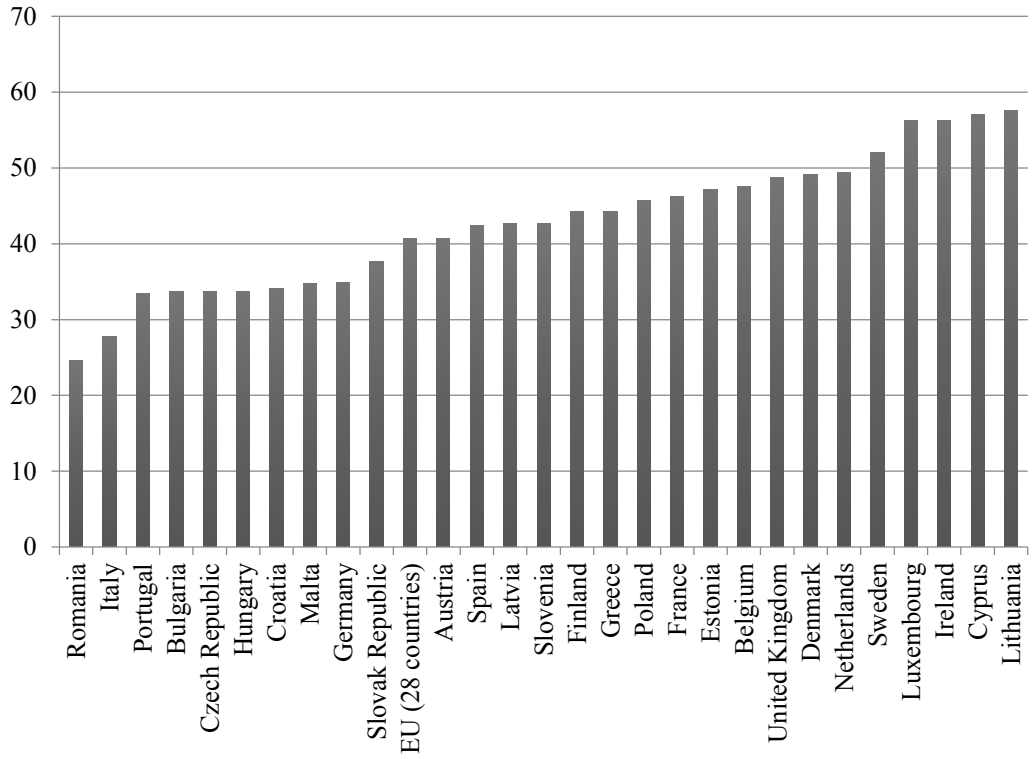

Figure 1. Tertiary educational attainment in the age group 30-34 (data in %). Source: based on the data of Eurostat, https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tesem030&plugin=1, November 26, 2019.

Studies pertaining to the career paths of tertiary graduates in Poland have been developed primarily due to the statutory requirement imposed on universities with respect to monitoring the professional progress of graduates, which came into force on 1 October 2011 (Act of 18 March 2011). Prior to the introduction of this obligation, only 33.3% of Polish universities conducted studies of this kind (Dziewulak, et al., 2014). As the studies were carried out independently by each individual university, they varied significantly in terms of the methodologies employed, which greatly hindered any comparative analyses (Pacuska, 2014).

The statutory change introduced in 1 October 2014 (Act of 11 July 2014) entrusted the minister responsible for higher education with monitoring the professional careers of graduates based on information provided by universities (currently via The Integrated System of Information on Science and Higher Education – POL-on) and the Social Insurance Institution (ZUS). The data gathered by the Minister have been published since 2016 via the national system of monitoring the economic vicissitudes of graduates (ELA), available at https://ela.nauka.gov.pl.

Although the ELA system is currently the largest available source of information on the post-university careers of tertiary graduates in Poland, it is not without certain limitations. Firstly, the data processed by the system are limited mainly to the scope of economics. Secondly, the data utilised by the system are gathered as part of the administrative tasks of the institutions managing the same data, and are therefore not adapted to research purposes.

Thirdly, information obtained from administrative registers does not include feedback from the graduates themselves or their employers (Information materials on…). The problems, limitations and advantages inherent in studies based on administrative registers have been broadly discussed by Jasiński et al. (2015).

The limitations of the ELA system necessitate additional research to be conducted on the career paths of tertiary graduates. Furthermore, the changes observed in the labour market and the related evolution of requirements applicable to potential future employees mean that such research should be carried out on a continuous basis. Despite the introduction of the ELA system, many universities elect to conduct independent studies into these issues, mainly through collaboration with careers offices. The professional advancement of university graduates is also monitored by Provincial Labour Offices, as well as the Central Statistical Office.

When analysing the results of Polish studies focusing on the career paths of tertiary graduates one can observe that they are conducted relatively rarely given the context of managing the human capital of graduates.

5. Human capital of tertiary graduates relative to employability

In order to identify the key elements of human capital that influence the employability of graduates, we used the data gathered in the study on "Professional Careers of Tertiary Graduates in Lublin Province" (Gach, and Krzesiński, 2017) conducted in 2017 by the Provincial Labour Office in Lublin. The study utilised the technique of CAWI (Computer Assisted Web-based Interview).

For the purposes of the article, a targeted selection was performed by choosing 1,375 cases out of 1,865 entries available in the database, based on the following criteria: graduation from a university in Lublin, residence in Lublin Province, and being employed. The most numerous group was composed of graduates from social studies faculties (53.8%), followed by natural sciences (15.6%), humanities and arts (9.5%), engineering and technical sciences (8.8%), medical and health sciences (6.5%), and agricultural sciences (5.8%). A vast majority of the respondents were graduates from second-cycle programmes or full-time master's level programmes (88.8%), with nearly one in ten having graduated from first cycle programmes (11.2%).

For the purposes of this article, the following elements of human capital were taken into consideration: education, experience, skills, and personal attributes. Three research questions were posed. Firstly, whether graduates are or have been employed in positions consistent with the direction of their university education. Secondly, how many of the students gained actual professional experience during their studies, and in what form. And finally, what skills and personal attributes of the graduates had an influence on their employability.

Graduation from a higher education institution is, but general assumption, an important factor determining future employability. One in three of the respondents never practiced or do not currently practice their acquired profession (Table 1). Nonetheless, graduates from the following fields of study were the most likely to practice or have practiced their acquired profession: medicine and dentistry (88.6%); architecture and construction (86.1%); biology and chemistry (82.1%); nursing, physiotherapy and pharmacy (80.8%). Naturally, one has to remember that the ability to find employment in ones acquired profession may depend on the specificity of the field of study, one's personal attributes and skills, as well as the current market demand.

Table 1.
Practising the profession acquired in the course of studies

	Practising the acquired profession	
Field of studies	**No**	**Yes**
Medicine and Dentistry	11.4%	88.6%
Architecture and Construction	13.9%	86.1%
Biology and Chemistry	17.9%	82.1%
Nursing, Physiotherapy and Pharmacy	19.2%	80.8%
Transport and Logistics	20.8%	79.2%
Veterinary and Zootechnics	21.6%	78.4%
Psychology	21.7%	78.3%
Economics and Finance	25.0%	75.0%
Sports and Beauty	25.0%	75.0%
Law	26.1%	73.9%
Information Technology	29.4%	70.6%
Administration and Management	31.2%	68.8%
Technology and Mechanics	35.3%	64.7%
Journalism and Information	36.4%	63.6%
Mathematics and Physics	39.3%	60.7%
Education and Social Services	39.4%	60.6%
Humanities	40.5%	59.5%
Geography and Tourism	41.3%	58.7%
Agriculture, Horticulture, Forestry, and Fishery	41.9%	58.1%
Social Sciences	44.5%	55.5%
Production and Processing	47.1%	52.9%
Environmental protection	64.1%	35.9%
Total	445	930

Source: authors' own elaboration.

As evidenced in the studies on the expectations of employers towards tertiary graduates, the most common requirement is that of having certain professional experience acquired in the course of the studies (Halik, 2013). Furthermore, research conducted in a group of nearly 17 thousand unemployed persons aged between 18 and 25 years revealed that the extent of such professional experience has a significant bearing on the level of unemployment. The lower the experience, the greater the threat of long-term unemployment (Wojdyło-Preisner and Zawadzki, 2015).

In the present study, the respondents were asked whether they had taken any steps towards gaining professional experience prior to graduation. Nearly 2/3 of the graduates turned out to have had gained some experience in the course of their studies (66.3%). The same was most commonly accomplished in the form of mandatory internships (20.8%), and commission or task-based employment (17.7%). Other forms of placement (11.9%), employment contracts (11.4%), voluntary work (10.7%), voluntary internships (10.3%), unregistered or non-contractual employment (9.9%), work at companies or farmsteads belonging to one's family (3.9%), and running one's own business (3.6%). Respondents were also asked to identify the greatest barriers experienced when seeking employment. The results clearly suggest that the most significant obstacle in finding desirable employment was the lack of sufficient professional experience (30.2%). These findings mean that universities do not fully support students in gaining future employment because 1/3 of students do not gain any professional experience while studying (33.7%), and almost 1/3 of students go to mandatory internships with the help of their university (31.1%).

The respondents were further asked to identify the key competencies needed in their presently occupied position. When choosing from among 24 provided answers, they most commonly indicated: diligence and meticulousness (7.1%), self-reliance (6.8%), work organisation (6.8%), communication skills (6.6%), resilience to stress (6.6%), and engagement (6.1%). (Table 2). This suggests that the curricula of tertiary education courses ought to more strongly emphasise the development of these particular competencies.

Table 2.
Key competencies in the currently occupied position

Competence	Number	Percent of responses	Percent of cases
Diligence and meticulousness	933	7.1%	67.9%
Self-reliance	896	6.8%	65.2%
Work organisation	903	6.8%	65.7%
Communication skills	874	6.6%	63.6%
Resilience to stress	876	6.6%	63.7%
Engagement	805	6.1%	58.5%

Note. Respondents could choose more than one answer. Source: authors' own elaboration.

In the subsequent part of the questionnaire, the respondents were asked to choose from among 12 strengths important in the context of professional activity. The most common selections were personality traits (18.9%), having specific qualifications and competencies (16.7%), industry-specific knowledge (12.3%), and only in fourth place the completed course of study (11.3%) (Table 3). However, when the analysis was narrowed down to only those graduates who work or used to work in their acquired profession, the field of university study was the most commonly selected attribute.

Table 3.
Key attributes of respondents in the context of professional activity

Attribute	Number	Percent of replies	Percent of cases
Personality traits	882	18.9%	64.1%
Specific qualifications or competencies	782	16.7%	56.9%
Industry-specific knowledge	572	12.3%	41.6%
Field of study	527	11.3%	38.3%
Adequate professional experience	477	10.2%	34.7%
Readiness to retrain	473	10.1%	34.4%
Mobility	300	6.4%	21.8%
Professional experience gained in prestigious institutions	249	5.3%	18.1%

Note. Respondents could select more than one attribute. Source: authors' own elaboration.

Respondents were also asked to consider the question of requirements they had to satisfy in order to secure their present employment (Table 4). When evaluating 12 of the provided possible options, they most often selected the need to develop one's already possessed qualifications (18.2%). The need to improve one's qualifications may stem, at least to some extent, from the general character of the university curriculum, as well as the increasing level of professional specialisation. At the same time, however, one of the main requirements imposed by employers relates to various aspects of employee availability, in particular: general full availability (12.6%), readiness to accept flexible working hours (10.9%), regular commute to locations distant from one's place of residence (10.3%), mobile work and business travel (5.6%). Those requirements stem from modern organisations' need for flexible management which allows human capital to be adjusted to environmental requirements (Juchnowicz, 2016).

Table 4.
Key requirements related to the currently held position

Requirements related to the currently held position	Number	Percent of replies	Percent of cases
Development of already possessed qualifications	514	18.2%	37.4%
Full availability	354	12.6%	25.7%
None of the above	315	11.2%	22.9%
Readiness to accept flexible working hours, e.g. work at night, on bank holidays	307	10.9%	22.3%
Regular commute to locations distant from one's place of residence	289	10.3%	21.0%
Complete retraining relative to the previously acquired/practiced profession	253	9.0%	18.4%
Starting one's own business	175	6.2%	12.7%
Mobile work/business travel	158	5.6%	11.5%
Purchase of a work tool, e.g. a car, specialist machine, computer	155	5.5%	11.3%

Note. Respondents could select more than one requirement. Source: authors' own elaboration.

Furthermore, it is also worth noting the degree to which the respondents' knowledge and skills acquired during university studies are utilised in their work, as assessed by graduates actually working in their acquired profession. It turns out that 7.1% never use the knowledge and skills acquired during their studies, 15.6% do so sporadically, 29.1% from time to time, 21.8% often, and 24.3% on a daily basis. The results clearly indicate that the knowledge and skills gained during university studies are largely insufficient to effectively practice a profession, which may suggest a certain incompatibility between university curricula and the

actual needs of employers, which necessitates further development of one's human capital outside the academic environment.

6. Summary

The presented results of studies conducted in a group of tertiary graduates revealed that roughly one in three respondents do not practice their acquired profession, hence the human capital of those university graduates is utterly wasted.

The results confirmed the importance of professional experience in the context of employability. It was observed that nearly 2/3 of the graduates made efforts aimed at gaining experience during their studies. This was most commonly accomplished by partaking in mandatory practical training and employment under commission or task-based contracts. The respondents also indicated lack or insufficiency of professional experience as the most important barrier when seeking employment. Universities do not fully support students in gaining future employment because 1/3 of students do not gain any professional experience while studying, and almost 1/3 of students go to mandatory internships with the help of their university. It is therefore of paramount importance that universities take steps aimed at activating students in acquiring greater experience, e.g. through practical training, internships, or employment during university studies.

The article also presents data regarding the key competencies applicable in the currently held position, strengths of graduates in the context of their professional activity, and the requirements of their current employers. When drawing up course curricula, universities ought to consider the development of such competencies as: diligence and conscientiousness, self-reliance, work organisation, communication skills, resilience to stress, engagement, and broadly understood availability.

The respondents indicated that the most common requirement in their present place of employment related to the development of already possessed qualifications. Respondents practising their acquired profession also reported considerable discrepancies between the scope of knowledge and skills acquired at university and the scope actually used in their work. This signifies that human capital must also be developed after completing university studies.

It is noteworthy that in response to the expectations of both employers and students, tertiary schools increasingly commonly introduce dual studies into their academic offers. The aim of such courses is to allow students to simultaneously gain academic knowledge as well as professional experience. The curricula of dual studies combine traditional academic classes with periods of employment in real-world enterprises. Students are therefore provided with the opportunity to gain actual professional experience consistent with their area of study, which will most definitely improve their future employability.

Analysing the career paths of tertiary graduates is a significant element of the efforts aimed at improving the overall quality of tertiary education and adapting it to the demands of the labour market. It should also be remembered, however, that employability is dependent on a whole range of factors. In future studies, it would also be worth analysing the specificity of the labour market. The analysis discussed in the present article is limited only to the labour market in the Lublin region, which is not without a certain specificity (Maleszyk, 2013). A comparative analysis could therefore be considered to include the perspective of other provinces, as well as the country as a whole. It also seems interesting to use a scale by Gunwan et. al. (2018) to measure young adults' perceptions of their future employability.

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MANAGEMENT AND LEADERSHIP IN TECHNOLOGY TEAMS – EMPIRICAL RESEARCH

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Abstract: The research goal was to analyse an employee's position from the top management's point of view, defined in two dimensions: employees' potential and their effectiveness. The article uses a brief literature review and qualitative research based on interviews with management. The interviews were conducted in two time intervals – the first part in 2018 and the second part in 2019. In the research, top management consisted of a Chief Executive Officer, an Agile Coach and a Human Resources Business Partner. The people in the above positions were responsible for retaining employees, creating possible development paths, and the utilization of human potential. Additional research purposes were to find out how the employee's position has changed over the years, and how much the leader's position in the team has influenced the changes. The study covered the situation of 34 programmers and IT analysts who worked in 8 technology teams. The assessment of the situation before and after twelve months showed real consequences of the management's decision-making process and provided recommendations for future research.

Keywords: career management, leadership, effectiveness, technology.

1. Introduction

In spite of a better understanding of leadership and effective people management, the issue is still a common goal of leadership and human resources management studies, two independent fields of study. Therefore, researchers (Leroy, et al., 2018) have recommended to integrate them to demonstrate how human resources management and leadership co-determine employees' motivation and performance. Also, employee retention is currently a huge challenge for management, especially in IT companies (Pflügler, et al., 2018). Given the importance of IT professionals in today's high-technology-driven business environment, it is essential to retain and fully utilize employees' performance potential, simultaneously empowering their engagement and increasing their effectiveness (Erturk, and Vurgun, 2015).

Organizational management practices have been recognized as crucial variables for employees' effectiveness and success. According to Bagdadli and Gianecchini (2019), the relationship between organizational investments and career development remains

underdeveloped. Empirical studies of the connection have provided inconsistent results. Based on a systematic review of three empirical practices, relational, developmental and informational, the following mechanisms have been identified: assessment and development centre, performance appraisal, training, career paths, mentoring, studies, external seminars, lateral moves, job rotation, job enrichment and succession planning. In the latest directions for human resources management, it has been highlighted how important it is to create internal leadership pipelines that span entry-level employees to executives, rather than consider succession planning and leadership development as distinctly different initiatives (Griffith, et al., 2019). Goal orientation and leaders` style of working can influence trust and outcomes of results (Chen, Lin, 2018).

It is worth noting that employees' effectiveness and efficient utilization of their potential does not depend only on employees themselves, but more on management. Management practices have been proved to have an impact on employees' effectiveness (Rani, and Kumar, 2018). Top management has an influence on successful leadership behaviours (Bildat, Schmidt, 2016). Therefore, to provide a satisfying level of effectiveness of high-potential employees, top management should create an adequate work environment.

2. Research methodology

According to De Vos and Cambre (2017), career models often omit the role of the organization. Therefore, this empirical research has filled the research gap and shown the employees' effectiveness and potential from the top management's point of view, as shown in Table 1, where the research questions and hypotheses have been identified.

Table 1.
Research questions and hypotheses for management and leadership in technology teams

Research questions	Hypothesis
How will the employees' effectiveness and potential levels change in twelve months?	H1: From top management's point of view, twelve months is enough time to change the employees' effectiveness and potential levels in teams.
What will top management do, based on the research results?	H2: Based on the research results, top management will prepare employee development plans.
What kind of changes will take place? Will the situation change or improve?	H3: In the case of the implemented employee development plans, the employees' positions will change.
To what extent is it possible to predict employee retention, based on the employees' performance marked on the effectiveness and potential matrix?	H4: Based on the employees' performance marked on the effectiveness and potential matrix, it is possible to predict employee retention.
To what extent is a leader's position related to a team member's position?	H5: A leader's position is related to a team member's position.

An essential part of the research was related to team leaders and top management's perception of their positions in the group. Moreover, the assessment of the situation, before and after twelve months, has highlighted the consequences of the management's decision-making processes.

All the management activities should lead to an increase in employees' engagement, motivation and utilization of their potential, where employees' potential, defined as knowledge, skills, and competencies, is a stem of human capital (Spurk, et al., 2019). Leveraging human capital and management team development issues, according to O`Neill and Salas (2018), are pathways for achieving the full potential of teams and creating high-performance organizations.

Job performance has been defined as the extent to which employees meet their job requirements according to their manager's instructions (Groen, at al., 2017). The performance can be measured at individual, team and organizational levels (Zorinsky, 2014). Researchers (Salas, et al., 2015) have demonstrated how essential understanding and improving teamwork is. Therefore, this empirical research was conducted in two ways: for every worker individually and from the team's perspective.

The research was conducted as group interviews with the biaxial matrix as an auxiliary tool. The interviews were divided into a few stages. In every stage, groups of the same three people were directly involved: Chief Executive Officer, Agile Coach and Human Resources Business Partner. The aim was to reflect the real environmental conditions. For the purpose of the research, only top managements having daily contact with team members were selected. Thanks to that criterion, the top management teams were able to observe samples of the employees' behaviours during the interviews.

Indirect research groups consisted of employees who worked in technology teams. The study covered 34 workers in 8 teams (marked A-H), which meant 3 to 7 members per group. The team members consisted of 32 males and 2 females employed as programmers or IT analysts, responsible for the creation, development and implementation of IT software. The workers did not participate in the interviews because the research goal was to analyze the employees' status from top management's point of view. During the interviews the Chief Executive Officer, Agile Coach and Human Resources Business Partner used the employees' names. After completing the results matrix, the data were anonymized.

The research procedure and schedule were followed. Quality researches were conducted in two parts. The first part was implemented in 2018 and the second one in 2019, after twelve months. Each time, the same procedure was implemented with the same people in the posts: Chief Executive Officer, Agile Coach and Human Resources Business Partner. The research procedure was as follows:

– Chief Executive Officer, Agile Coach and Human Resources Business Partner worked with the biaxial matrix (horizontal axis – the level of potential, vertical axis – the level of performance). Each of them had their own matrix.

- Together they constructed and agreed on the definition of variables to achieve a common reference which included: timely task completion, quality of work, problem-solving. The employee's potential was defined as the individual's knowledge, skills and competencies (including education, general mental ability, and the ability to cooperate).
- Each of them independently placed the names of team members on the matrix, in places which fit best according to them. This part was done in silence, without any consultation.
- When everyone had finished completing the matrix, they showed the results and the interview started.
- Every team member's position was analyzed on three matrices. The Chief Executive Officer, Agile Coach and Human Resources Business Partner exchanged opinions, gave examples of behaviours and made decisions. At this stage, the fourth matrix was made.
- The analysis of the particular employee's position was conducted until the moment management agreed on the position. After management came to a joint decision, the employee's name was placed on the fourth matrix.
- The procedure was conducted for every team member to complete the fourth agreed matrix of the team.
- For every employee, possible development paths and management activities to boost their potential were defined.
- The above research procedure was repeated by the Chief Executive Officer, Agile Coach and Human Resources Business Partner for every technology team.
- The interviews, carried out in 2018, focused on the employees' development plans. The interviews in 2019 also included questions about the changes which had taken place over the past twelve months.

Every organization has employees with potential, but matching them to the right post is a huge challenge. This potential should be used at team and organization levels. From the business point of view, performance and results are crucial. Therefore, those two perspectives were taken into account in these researches. Moreover, repeating research after twenty months enabled us to enclose time perspective and long-term outcomes.

3. Results

The results are illustrated in Figure 1. The information about Team A to Team H is shown together in order to compare the trends. Formal team leaders are marked with filled circles. Black circles present the employee's current position (2019), and grey circles demonstrate the employee's former position (2018).

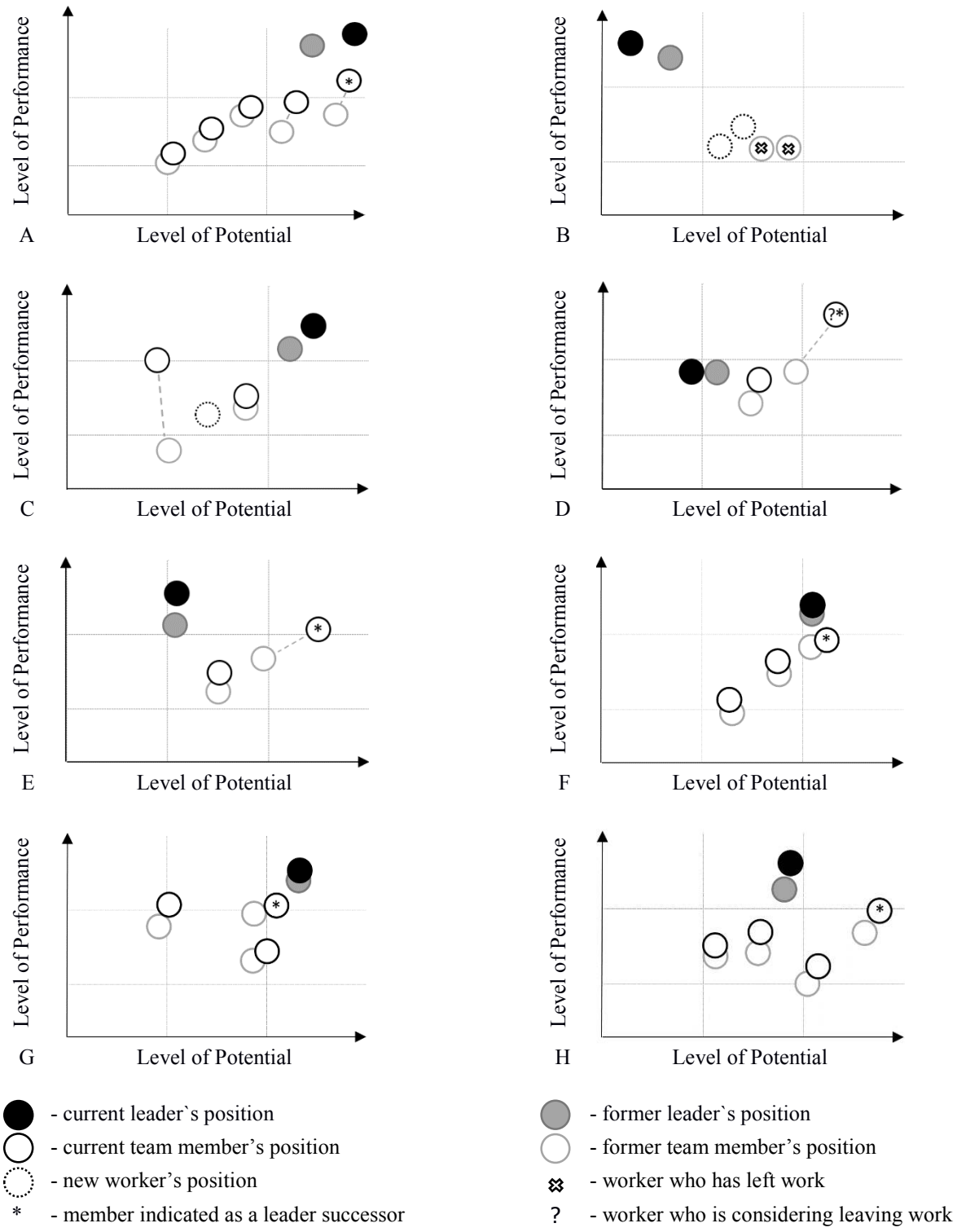

Figure 1. The employee's position from top management's point of view (before and after 12 months).

Based on the discussions conducted during the respondents completing the matrix, and according to the information presented in Figure 1. The employee's position from top management's point of view. Five hypotheses have been found:

- H1 – partly supported

  The research confirmed that twelve months was enough time for management to change employees' effectiveness and potential levels, which was clearly visible in A-H teams. However, it is surprising that without looking at the first matrix, the respondents indicated quite similar employees' positions. Only a few workers were placed differently than was done earlier. The reasons for this situation, identified during the interviews in 2019, were the following: the teams focusing on the products, not projects, tasks requiring substantive knowledge; team members taking part in the training activities; a relatively stable situation according to top management; small staff changes initiated by management.
- H2 – partly supported

  Based on the conclusions made from the employees' effectiveness and potential matrix, top management designed employees' development plans for a few leaders, high-potential employees and workers with the lowest level of effectiveness. They last ones were also provided with additional support of one-on-one meetings and training.
- H3 – supported

  The third hypothesis, i.e. in the case of the implemented employee development plans, and the employees' positions change, has been supported. The development plan included the following activities: providing mentoring, changing tasks and duties, giving more autonomy, and cooperation with younger employees to share knowledge. Additional activities were accelerated through internal and external training. The positions of the employees with the implemented development plans have apparently changed. Management recognized those activities as very positive. New development plans have been constructed on the basis of the matrix done in 2019.
- H4 – supported

  Based on the employees' positions on the effectiveness and potential matrix, the hypothesis that it is possible to predict employee retention has been supported. In Team B, people with lower effectiveness levels felt uncomfortable in their teams. They did not have any reinforcement from their leader. The conclusion is that workers with lower effectiveness levels should take on additional activities.
- H5 – strongly supported

  The strongest evidence has confirmed that the leader's position is related to a team member's position. In teams where low-potential employees were recognized, different kinds of difficulties appeared. In Team B, the workers left the team. In Team D, the most valuable high-performing programmer was considering leaving the organization. The team members have not only followed the high-potential leaders, but also increased their performance under effective guidance.

4. Discussion

The research results have led to particular and general conclusions. It is possible to highlight challenges in the management of technology teams. In Team A, the members have followed their leader, the person with the best performance and high potential. Every team member has been positively recognized by the management. Moreover, the member who presented high potential levels during the interviews has been indicated as a possible successor for the leader's role in the future. Over a period of twelve months this person got additional development tasks, e.g. decision making, mentoring junior team members, and guidance of students during their training. The most difficult challenge for management in Team A was to provide the current leader, who was considering changing organization, with new tasks and development paths to ensure positive changes in his professional development. This has been seen as vital because leaders' high effectiveness levels can bring them greater professional freedom and ensure them greater mobility in the labour market. This can be both a challenge and a risk, as high team performance cannot be built without a good leader. During top management's discussions, it turned out that the leader had soft skills, technological knowledge, and strong social influence on other team members, which meant a great potential to be used at higher organizational levels.

A different situation was observed in Team B, where the leader had a lower potential level. Moreover, two team members decided to leave the team between the first and the second parts of the research. They made a joint decision to leave at the same time. The management decided to rebuild the team temporarily and hired two new programmers. The fact of two employees quitting their jobs induced a higher demand for increased team monitoring. Perhaps, a formal leader in this case should be more of an independent consultant rather than a team leader. Top management considered a consultant post for the current leader, expanded the team, and a new leader emerged from the team members and supported the current and future leader with coaching and other development tools, also recommended in the research literature (Ladegard, and Gjerde, 2014).

In Team C, the leader accelerated the employees' results. Management decided to introduce a new employee to the team. The team member, recognized as not efficient enough, was given new tasks and duties, which meant more autonomy and independence in the new position as a consultant. As a result of the change, after twelve months significant changes had been noticed in the perception of this person, which resulted in his career advancement.

A difficult situation was observed in Team D, where the leader did not present enough potential. The high-potential programmer with a promising effectiveness level informed management about their intention to leave the organization, which would be a total loss to the team. The person had all the necessary advanced technical and soft skills. To avoid conflict in the team, the management decided to create new opportunities for this programmer to lead

a new project, planned to be run in the following two months. According to management, it was the only way to prevent the worker from leaving the organization.

In Team E, the leader had a stable potential level and high effectiveness. The leader has strongly accelerated his successor's development, more than had originally been planned. In Teams F, G and H a similar situation has been observed. The leaders, who had satisfactory potential and effectiveness levels, were sharing their responsibilities and duties with other team members who were more eager to follow them. This is an important observation which should be developed in the future. Large-scale researches are related to leaders, but it has also been recommended to do research devoted to team members who can be the most valuable followers to leaders (Epitropaki, et al., 2017). It has also been proved that they can influence one another's behaviours, which can result in the increased effectiveness of both groups (Oc, and Bashshur, 2013).

In the research the leader had a significant role. The research investing leadership development suggests it is necessary to relate to the leaders' performance and their social capital (Subramony, et al., 2018). However, management should also create development paths for other team members, especially for successors, to prepare them for team leading roles. In many literature reviews, it is emphasized that team members can become informal or formal leaders when the organizational structure changes or when a shared leadership style is introduced (Qiong, and Cormican, 2016). Also, putting Implicit Leadership Theories or Leader-Member Exchange into practice can help to predict job performance (Khorakian, and Sharifirad, 2019).

At the time of the interviews in 2019, additional arguments were raised which focused on the question why a particular person is chosen for the leadership role. It turned out that earlier, the employee's potential had not been included in the criterion of promotion. Knowledge, experience and technical skills were essential. Moreover, seniority was one of the main advantages that can bring higher status, rank and precedence in the promotion process. Admittedly, knowledge about the organization is valuable, but it is definitely not enough to lead a team successfully. Also, talent management and career development paths can be different in different countries (Latukha, and Selivanovskikh, 2016), e.g. because of cultural dimensions (Feitosa, at al., 2018).

As a major conclusion, it is essential to highlight that leaders' positions are crucial to provide development opportunities for team members. A low potential leader may cause decreasing satisfaction, low morale, and eventually make employees' leave the organization. On the other hand, a leader with high potential and effectiveness levels accounts for team members' personal growth and professional development.

Based on the results, the following general conclusions have been formulated:

- Accelerated performance and development of team members is evident in teams where a leader is viewed as the most valuable person (teams: A, C, F, G, H). In that situation team members follow their leader.

- A person without a high potential level should not be a leader as it increases the risk of employees' leaving the team.
- A team member with higher potential and effectiveness levels than a leader increases the risk of conflict.
- Successors have been revealed – the insight discovered during the research.

This research has many limitations. The first and the most obvious limitation is the size of the sample research group. Secondly, it is necessary to state that effectiveness and potential cannot be objectively measured, but examined on the basis of the respondents' own perceptions. Eventually, leadership styles might have a mediating effect on the results. As has been emphasized (Fischer, et al., 2017), leadership might be analyzed at individual, team, organizational or even external levels. Communicating shared vision and implementing leadership styles might enhance performance at a completely different level (Adnan, and Valliappan, 2019).

Furthermore, the effectiveness and utilization of human potential are related to job engagement, intention to change the team, or even leave the organization. It is recommended to conduct additional research on the issues. As researchers (Yu, and Wu, 2017) have claimed, the reality is more complex, and this research has deepened our knowledge only in some of the aspects of the work environment.

5. Summary

Substantiation of using the qualitative research has had both scientific and business objectives. The major value of this research has been the exposition of the employees' performance and potential from the management's point of view, especially that top management usually have the power to decide about staff transfers and promotions. The major purpose of the interviews was not to assess the employees. Top management have also not intended to rate workers. The most significant value has been to discover and analyse employees' predispositions based on specific situations. As a result, top management have been able to create possible development paths, notice changes, and become more aware of the consequences of the decisions they have made.

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