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SATISFACTION, ENGAGEMENT AND ORGANISATIONAL COMMITMENT OF EMPLOYEES – REVIEW OF THE CONCEPTS AND PROPOSAL FOR A RESEARCH MODEL

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Abstract: Satisfaction, engagement and organisational commitment of employees are undoubtedly crucial elements when developing an effective organisation. The ambiguity of these concepts and the multiplicity of definitions hinder the analysis of the available studies. In this article, the author attempts to review the available concepts of these phenomena, indicates the relations between them as well as presents an original research model as a proposal for a starting point for further research.

Keywords: satisfaction, engagement, organisational commitment.

1. Job satisfaction

Although the origins of systematic job satisfaction surveys date back to the 1930s, this theme continues to intrigue the researchers and management practitioners. By observing the research of the last few years we can even talk about a Renaissance of the interest in this topic.

A review of the definitions indicates two ways of interpretation of the essence of job satisfaction and career contentment (Juchnowicz, 2014, p. 11):

1) The first way exposes the emotional nature of these concepts, limiting them to the sphere of feelings. E.A. Locke defines this concept as a "pleasurable emotional state that results from the perception that one's job fulfills or enables the fulfillment of one's important job values, providing and to the degree that those values are congruent with one's needs" (Locke, 1976) Cited Locke described job satisfaction as a result of the perception of one's own job as such that enables the achievement of important job values provided that those values are compatible with one's needs or help in the implementation of basic human needs.

2) According to the second approach, job satisfaction and career contentment constitute a specific attitude towards work. The possibility to fulfill one's own values and objectives is seen as the basis for the development of employees' attitude towards their job. A representative of such an approach is V.H. Vroom, who defined satisfaction as an attitude; therefore, according to him, a positive attitude towards work is the same as job satisfaction. Vroom develops his considerations in the assumptions of the commonly known expectancy theory, where the key to employee satisfaction is to fulfill the employees' expectations (Vroom, 1964, p. 99).

It derives from the above definitions that what employees consider valuable at work results directly from their internal needs. At the same time, achieving results valued by employees is tantamount to their satisfaction.

Under the assumption that the job satisfaction is a part of the attitude, it seems necessary to cite its another definition. The most common definition of attitude is derived from social psychology where it is understood as a relatively permanent approach of an individual towards someone or something, an entity, object or idea. This approach involves three components: cognitive, affective and behavioural (Aronson, Wilson, and Akert, 2006, p. 81, 184-185). By applying the above definition to the workplace situation, the following components can be distinguished:

- in the cognitive aspect – the knowledge of employees on the performed work, awareness of the situation, judgements and opinions on the performed tasks and work environment,
- in the affective (emotional) aspect – affections and antipathies, both short-term and permanent attitude to the performed work, implemented tasks, objectives and people,
- in the behavioural aspect – tendencies and activities related to the subject towards which the attitude is analysed, which in this case is the performed work.

It should be noted that these components interact with each other and employees develop a number of partial attitudes (towards the job, co-workers or organisation) that ultimately determine the behaviour of the employee.

In some analyses of the behaviour of employees in the organisation, the attitude is identified both with the emotional (satisfaction) and normative aspect (a collection of opinions, judgements and beliefs) (Brief, and Weiss, 2002, p. 279-307). In many jobs, as well as management practices, the terms job satisfaction and career contentment are sometimes used interchangeably. It is difficult to presume that one can feel satisfaction and be discontent, and the other way around – be content and not satisfied. Therefore, the concept of job satisfaction and career contentment are treated in source literature, in dictionaries and in this article as synonyms (Słownik języka polskiego, 1989, p. 193, 900; Słownik synonimów, 2007, p. 380).

Diverse understanding of the concept of job satisfaction leads to problems when trying to compare the results of studies conducted on this subject. It seems indisputable that job

satisfaction is a positive approach of employees to their duties, working environment and co-workers, and that this phenomenon is accompanied by a feeling of satisfaction.

Satisfaction can undoubtedly be a positive feeling, but it may also be negative. The same situation may be satisfying for one person and not for another. It consists of many elements and it is influenced by many factors of different value to different people.

The fact that engagement is strongly connected to satisfaction cannot be omitted. The existence of such a relationship is confirmed by D.A. Peterson (Peterson, 2004, p. 296-319). According to M. Juchnowicz, job satisfaction and career contentment are the predictors of subsequent behaviour of employees in the form of their engagement (Juchnowicz, 2010, p. 59). Also according to M. Bugdol satisfaction may be a result of engagement. Without satisfaction there is no long-term engagement, and the short-term engagement may be forced (Bugdol, 2006, p. 89). Employee engagement may in turn result in civil behaviours. They are associated with taking voluntary actions by employees for the sake of the organisation; actions that are not explicitly included in the incentive systems.

2. Engagement

Employee engagement is important for the proper functioning of every organisation. From the point of view of an organisation, employee engagement may manifest itself in going beyond one's duties or showing initiative at work.

Table 1 provides an overview of the definitions of engagement occurring in the source literature.

Table 1.
An overview of the definitions of engagement

Author	Definition
W.A. Kahn, 1990	It consists in expressing oneself in the working environment through goal-oriented activities promoting relationship with the company, personal participation as well as active and comprehensive fulfillment of roles. It is a psychological condition that enables employees to express themselves physically, cognitively and emotionally.
W.A. Kahn, 1992	A dynamic, dialectical relationship between a person directing their personal (physical, cognitive and emotional) energy towards fulfilling roles and a job that makes it possible to express oneself.
M.P. Leiter, C. Maslach	The opposite of the negative state of burnout, understood as vivid experiencing of the relationship with activities generating personal satisfaction and increasing the sense of meaning of the professional efficiency of employees.
C. Maslach, W.B. Schaufeli, M.P. Leiter, 2001	Persistent, positive, emotional and motivational state of accomplishment experienced by personnel, characterised by a high level of activity and pleasure.
N.P. Rothbard, 2001	Two-dimensional motivational category including attention, relating to cognitive abilities and time period devoted to think about a given task, and absorption, meaning the level of absorption in the performed task and the intensity of attention paid to that task.

W.N. Schaufeli, M. Salanova, V. González-Romá, A.B. Bakker, 2002	Positive, giving a sense of accomplishment, work-related state of mind characterised by vigour, dedication to work and absorption in work.
J.K. Herter, F.L. Schmid, T.L. Hayes, 2002	It refers to passion and satisfaction with work, as well as the enthusiasm for work.
D.R. May, R.L. Gilson, L.M. Harter, 2004	Employees express themselves in the physical, emotional and cognitive aspect through engagement (conceptualisation of Kahn's definition, 1990).
A.M. Saks, 2006	Separate and unique category that includes the cognitive, emotional and behavioural components related to individual fulfillment of roles.
M. Czarnowsky, 2008	Employees that are mentally and emotionally involved in their work and contribute to the success of an organisation are referred to as engaged employees.
W.H. Macey, B. Schneider, 2008	Engagement understood as a feature refers to the character traits such as diligence, initiative, positive impact; engagement as a condition includes feelings: energy, absorption, satisfaction, participation, commitment and causative power; engagement as a behaviour is understood as the fulfillment of the assigned roles beyond the requirements, as civil behaviours, initiative and adaptive behaviours.
D.A. Newman, D.A. Harrison, 2008	Simultaneous presence of three elements in the behaviour of employees: efficient work, civil behaviours and commitment.
M. Juchnowicz, 2010	Attitude that makes it possible to treat engagement in a comprehensive manner embracing elements of behaviour, emotions and interests (the relationship of exchange between an employee and employer), formed under the influence of three groups of factors: cognitive, emotional and behavioural.
M.S. Christian, A.S. Garza, J.E. Slaughter, 2011	Relatively permanent state of mind relating to the simultaneous devotion of one's personal energy to experiencing or performing work.

Source: Kmiotek, 2016, p. 63-64.

An interesting approach to the issue of work engagement is presented by W.B. Shaufeli et. al. *Work engagement* is defined by them as a positive, rewarding, work-related state of mind that reflects one's attitude towards the performed work (Schaufeli, Salanova, Gonz´alez-Rom´a, and Bakker, 2002, p. 71-92).

The division of engagement that occurs most frequently in source literature includes:

- work engagement,
- organisational engagement.

Work engagement is a term introduced by W.A. Kahn who defined it as physical, cognitive and emotional self-expression at work (Saks, 2006, p. 602). Therefore, personal engagement means undertaking tasks and putting energy into work-related behaviours. It is also a means for self-expression.

In contrast, organisational engagement is seen as an attitude that reflects the nature and quality of the relationship between an employee and an organization (Parish, Cadwallader, and Busch, 2008, p. 32-52), or as the extent to which an entity identifies itself with the objectives and values of an organisation in its work (Macey, and Schneider, 2008, p. 3-30). Organisational engagement can manifest itself in the following behaviours (Juchnowicz, 2010, p. 37):

a) willingness to defend the company and its products in situations of crisis and conflict,

b) pride in one's work in the given organisation, identification expressed through statements such as "my company", "we", etc.,

c) demonstration of high activity and initiative,

d) long-term employment and lack of interest in changing the workplace,

e) availability and consent to work overtime when it is required by the situation,

f) understanding additional duties, willingness to take responsibility,

g) loyalty,

h) trust in superiors and co-workers.

In the English-language literature there are other similar concepts related to the involvement in professional activity, whose terms are difficult to distinguish in Polish, e.g. *job involvement* (Lodahl, and Kejner, p. 24-33), *work involvement* (Kanungo, 1982, p. 341-349) or *employee engagement* (Schaufeli, and Bakker, 2010, p. 10-24). These terms are distinct from the term *work engagement*, conveying them in Polish may be problematic and the differences in meaning between them are significant.

Job involvement is a commitment to a particular professional activity carried out at a given time that satisfies the current needs of the subject. *Work involvement* means a commitment to work in general and is the result of perceiving work as a value in life. *Employee engagement* in turn, translated as "zaangażowanie pracownicze" (Szabowska-Walaszczyk, Zawadzka, and Wojtaś, 2011, p. 57-74), aims at prosperity and development of the company and not at the well-being (which is a consequence of engagement in work) of the employee.

When considering the issues associated with involvement, it cannot be ignored that the commitment to work, in particular in the form of being absorbed in work, determines the level of commitment to the organisation (the so-called "organisational commitment") (Meyer, and Allen, 1991, p. 61-89). Therefore, work engagement and organisational commitment are closely related to each other. It seems important to explore the determinants of the high level of both work engagement and organisational commitment.

For example, work engagement and organisational commitment of public and private sector employees were studied in Ghana using comparative approach. Findings showed a significant positive correlation between work engagement and organisational commitment. It was shown that employees of private organisations manifest a higher level of work engagement and organisational commitment than employees of public organisations (Agyemang, and Ofei, 2013, p. 20-23).

2. Organisational commitment

As in the case of the term "engagement", there are numerous definitions of "organisational commitment" in the subject literature. Table 2 contains a list of the most common definitions of that concept.

Table 2.
Overview of the definitions of organisational commitment

Author	Definition
H.S. Becker, 1960	Tendency to engage in activities of a consistent sense of direction based on an individual exploration of the costs related to terminating a relationship.
R.M. Kanter, 1968	Readiness of social entities to devote their energy and manifest loyalty to social systems.
B. Buchanan, 1974	Awareness of lack of possibility to choose a different social identity or to reject a specific requirement under a threat of penalty, or an emotional attachment to an organisation with the exclusion of the purely instrumental value of a relationship.
G.R. Salancik, 1977	Condition in which a person feels obliged to act.
R.T. Mowday, R.M. Steers, L.M. Porter, 1979	Relatively strong identification of a person with a particular organisation and involvement in that organisation characterised by: a) an acceptance and deep faith in the objectives and values of the organisation, b) a willingness to put extra effort for the benefit of the organisation, c) a strong need to maintain the membership.
E.A. Locke, K.N. Shaw, L.M. Saari, G.P. Latham, 1981	Determination in achieving objectives regardless of whether they are commissioned, established in advance, or independently determined by the participant.
R.W. School, 1981	A stabilising force that maintains the course of action while the perspectives or circumstances are unfavorable.
Y. Wiener, 1982	Overall normative pressures to act in accordance with the course of action while the perspectives or circumstances are unfavourable.
A.E. Reichers, 1985	Process of identification with the objectives of many entities that constitute an organisation (e.g. management, customers and trade unions).
C.A. O'Reily, J. Chatman, 1986	Psychological bond connecting a person with an organisation, reflecting the degree of the person's internalisation or acceptance of an organisational perspective.
G. Blau, K. Boal, 1987	Condition in which an employee identifies oneself with a particular organisation and its objectives, and wants to maintain the membership in order to support its objectives.
N. Oliver, 1990	Tendency of a person to act in a specific way targeted at the object (entity) of attachment.
N.J. Allen, J.P. Meyer, 1991	Psychological condition that binds a person to the organisation and makes leaving the organisation less likely.
J.E. Mathieu, D.M. Zajac, 1990	Bond or relation of a person with an organisation
G.A. Zangaro, 2001	Act of oath or promise to someone or something to fulfill all obligations in the future. A person who is involved in an organisation, is committed to it and believes in its objectives and values.
J.P. Meyer, L. Herscovitch, 2001	A force that determines a person's course of action, resulting from the importance of one or more entities for that person. Engagement described in such a way differs from exchange-based motivational system and from goal-oriented approach, and may influence behaviours in the situation of absence of extrinsic motivational factors or positive attitude.

Source: Kmiotek, 2016, p. 22-23.

One of the models of *organisational commitment* that are most often analysed by researchers is the three-component model of Meyer and Allen (Meyer, and Allen, 1991, p. 61-89). This concept establishes that people commit to an organisation in three ways, so the proposed, operationalised model includes three types of commitment:

1) emotional (affective) commitment,
2) continuance commitment,
3) normative commitment.

Affective commitment is characterised by a high degree of commitment to an organisation and its objectives. An employee feels content and satisfied with being one of the members of a company, identifies with the organisation and its environment, manifests desire to work, as well as puts an effort in the implementation of tasks and missions of the company. The affective component then means an emotional attachment of an employee to the organisation, commitment to it and identification with it. Therefore, it can be concluded that employees strongly committed to the organisation in an affective manner are satisfied with work.

Continuance commitment is determined by the costs of leaving a company. This type of commitment develops when employees realise that they can lose what they have invested and achieved in the organisation if they leave, and when other work-related alternatives are limited. Therefore, the continuance commitment is an awareness of the costs related to leaving an organisation. With regard to the results of A. Bańka, it can be concluded that the longer the time of employment of an employee in a particular organisation, the higher the level of the employee's commitment, which manifests itself most through durability (Bańka, Bazińska, and Wołoska, 2002, p. 65-74). Therefore, it can be assumed that employees with longer working experience show greater commitment to the organisation, in particular in the case of continuance commitment.

Normative commitment refers to the feeling of obligation to stay in the organisation and continue the work; employees stay with a particular employer because they think that they should. It is formed on the basis of a mandatory duty and obligation which are based on: benefits and reciprocity principle, internalisation of social norms, or psychological contract. Organisational commitment understood in such a way indicates maintaining a relationship with the entity (organisation), and expresses a sense of moral obligation to remain in the organisation.

Studies show that organisational commitment leads to significant results such as: turnover increase, better motivation, growth of civil behaviours in organisations, organisational support (Kwon, and Banks, 2004, p. 602-622). Employees who are strongly committed to the organisation in an affective manner work more and get better results than those who present a low level of emotional commitment. Similar but poorer results are observed in the case of normative commitment. However, the correlation between continuance commitment and work results is unclear. Some studies suggest that there is no statistically significant correlation

between these variables. However, there are indications that employees with a higher level of continuance commitment show lower efficiency and poorer results (Spik, and Klincewicz, 2008, p. 489). A high level of affective and normative commitment is beneficial from the point of view of organisations, although the beneficial effects of the normative commitment are weaker and may be short-lived.

Therefore, from the point of view of organisation it is beneficial when its employees are experiencing the affective commitment. Emotional commitment is beneficial both for the employee and for the organisation; it evokes both positive emotions and attitudes towards the organisation and satisfaction with opportunities as well as enables self-realisation through work.

3. Relations between satisfaction and engagement

Analysis of the literature and empirical studies prove the correlation between satisfaction and engagement of employees and their commitment to the organization (Juchnowicz, 2009, p. 121-127). The subject of this discussion is the direction of these correlations and the answer to the question whether satisfaction influences engagement or the other way around – engagement determines job satisfaction. Management sciences and social psychology are dominated by the assumption that job satisfaction has positive impact on the level of engagement (Schultz, and Schultz, 2002, p. 307).

It is difficult to prove the explicit impact due to the fact that higher and better results may not occur, often for objective reasons, immediately after the occurrence of the conditions that have positive impact on the level of job satisfaction. Furthermore, the direction and force of the impact are determined by many external and personal factors. The notion of the coexistence of these two attitudes towards work was formed on the basis of the above and not on the basis of a cause and effect relationship (Bowling, 2007, p. 167-185).

Numerous models have been devoted to the relations between satisfaction and engagement and to the factors that shape them. One of the most popular models is the one proposed by W.B. Schaufeli and A.B. Bakker (Schaufeli, and Bakker, 2006, p. 41-50). Scientists admitted that it is impossible to formulate a comprehensive definition of engagement that would include all of the proposed approaches towards it, so they made an attempt to integrate the academic experience and proposed a model of engagement functioning in literature as a demands-resources model (fig. 1). In their model, the authors define work engagement as a specific psychological condition (which involves spending one's personal energy) consisting of vigour, dedication to work and preoccupation with it. They concluded that engagement is a factor that mediates the relationship between the influence of job resources and the influence of personal resources on organisational results. Work-related

circumstances (e.g. a job that is demanding and makes it possible to prove oneself) have a motivational potential that results in high engagement rate and excellent results. That motivational potential refers not only to intrinsic motivation (employee development, learning) but also to extrinsic motivation (means of achieving the objectives pursued). According to the authors, to evoke a specific psychological conditions some personal predispositions (e.g. optimism, self-esteem, faith in one's efficiency), which also have a motivational potential, are also necessary. At the same time, they show that job satisfaction along with commitment to work (the categories partly overlapping with work engagement) play a similar, intermediary role in the obtained results. Due to the fact that this is just a partial overlap, the authors deem it necessary to indicate those three positive psychological conditions as intermediary categories.

Ambitious work allowing to exhibit one's		Psychological state: • work satisfaction • work commitment • work attatchment		Benefits: • Organisational attachment • Personal initiative, performing tasks which exceed professional requirements
An emlopeey's positive attitude entrepreneurial				
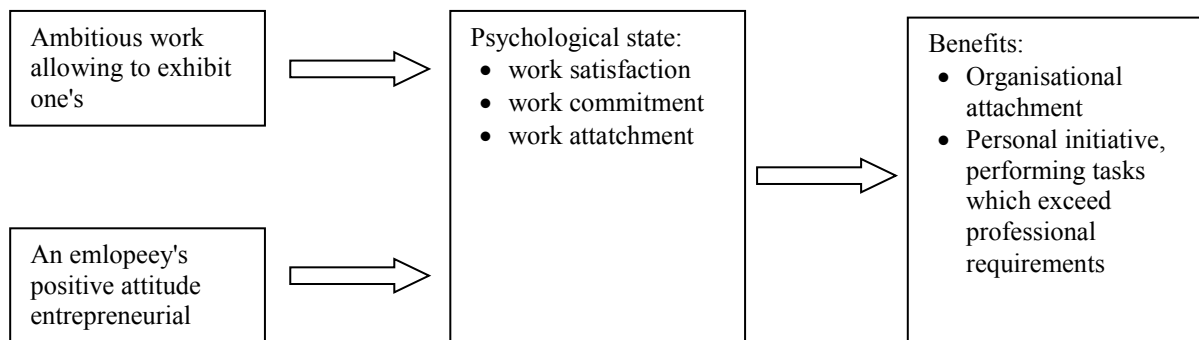
Figure 1. Model of engagement by W.B. Shaufeli and A.B. Bakker. Adapted from "Defining and measuring engagement in a cross-cultural workforce: new insights for global companies" by W.B. Schaufeli, A.B. Bakker. Global Business and Organizational Excellence, Vol. 26, Iss. 1, p. 41. Copyright 2006.

The question concerning the factors that influence satisfaction to the largest extent remains open. M. Juchnowicz believes that they include communication, organisation of work, relations with superiors, career development, human relations and remuneration (Juchnowicz, 2014, p. 65), and these factors have been implemented to the model proposed by the author of the article (fig. 2). According to the proposed model, these factors affect satisfaction and this in turn determines work engagement and organisational commitment.

Figure 2. Satisfaction in the employee management model (research model). Own study.

3. Pilot study

The research tool used to verify the presented model (fig. 2) was a survey questionnaire consisting of fifty-five questions, the vast majority of which was verified in other studies. Nineteen questions concerned human resources (Juchnowicz, 2014, p. 166) management practices, two concerned bureaucratic barriers, five concerned job satisfaction (Zalewska, 2003b, p. 54), nine questions were taken from the UWES-9 test (Seppälä, Mauno, Eldt, Hakanen, Kinnunen, Tolvanen, and Schaufeli, 2008, p. 479), eighteen questions regarding organisational commitment were taken from A. Bańka's version of Meyer and Allen's test (Bańka, Bazińska, and Wołoska, 2002, p. 70) two questions about resources were also added.

3.1. Research method

A pilot study was conducted between December 2015 and February 2016 using a survey questionnaire. A link to the survey was sent to capital cities of 16 provinces and to 60 municipal offices throughout the country. As a result of the conducted survey, 88 completed survey questionnaires were received, which have been subject to a statistical analysis described below.

At the beginning it was examined whether the theoretically extracted factors shaping satisfaction will also be determined analytically. For this purpose, a factor analysis was

carried out for 6 factors using principal component analysis with two rotation methods – Varimax rotation and direct Oblimin rotation. Varimax rotation is based on choosing such factors so that the inter-factor variation was as high as possible and the intra-factor variation as low as possible. Direct Oblimin rotation is based on the correlation between the variables which form each factor. The Varimax rotation was conducted first. The results of the KMO and Bartlett's Test are presented in Table 3.

Table 3.
Kaiser-Mayer-Olkin and Bartlett's Test

The KMO measure of sampling adequacy.	0.847
Bartlett's Test of Sphericity Chi-squared approximation	845.590
Df	153
Significance	0.000

Source: Own study based on the pilot study results.

The KMO test verified if reduction of the dimensions would produce results, i.e. if it makes sense to switch the 18 questions to a smaller number of indicators. A measure of above 0.5 indicates the merits of the application of factor analysis. It can be said that it was deducted, on the basis of the KMO = 0.85 result, that the reduction of the dimensions would bring significant results.

Then the Bartlett's test was checked. Based on the $x2(153) = 845.59$; $p < 0.001$ results of Bartlett's Test of Sphericity it was found that there were significant correlations between the parameters, therefore it was necessary to conduct a factor analysis in order to extract the factors. An indication as to the number of factors was Cattell's criterion based on a scree plot (fig. 3).
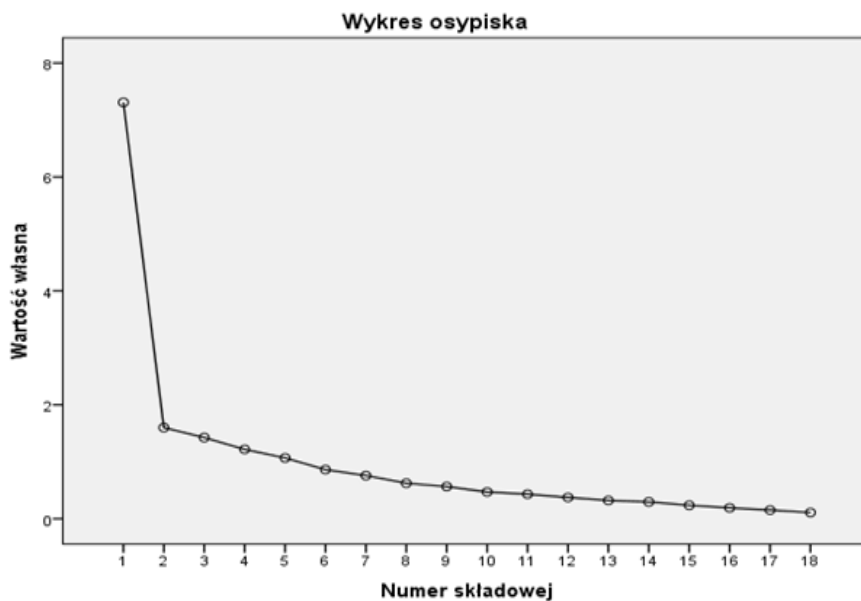
Figure 3. Scree plot. Source: Own study on the basis of pilot study.

The eigenvalue by which the curve starts to level off indicates the number of factors that should be extracted. It can be said that it was stated on the basis of Cattell's criterion that builds on the scree plot that it is worth to consider the extraction of two factors.

After conducting the factor analysis, the reliability of Cronbach's Alpha was analysed. The reliability of the scale is understood as the accuracy of the measurement. The Cronbach's Alpha measure determines the coherence of the values included in a given scale, in other words it determines whether the way of answering the questions was coherent. The higher the Cronbach's Alpha coefficient the more coherent the ratio that the measurements compose. It is assumed that values within the limits of 0.6-0.7 mean a satisfactory level of scale reliability in scientific research.

Table 4.
Reliability of the factors that shape satisfaction

Factors	Cronbach's Alpha coefficient
Career development	0.606
Remuneration	0.651
Relations with superior	0.883
Human relations	0.880
Communication	0.672
Organisation of work	0.700

Source: Own study based on the pilot study results.

It is visible above that even though the factor analysis did not show 6 factors, the reliability analysis for career development, communication and remuneration was only slightly below 0.7, and for other factors it was above this value. Therefore, it can be stated that the factors showed high reliability and the questions they included were coherent.

4. Summary

As presented in the article, there is no single, consistent definition of satisfaction, engagement and organisational commitment. The debate on these terms is still valid and attracts the interest of researchers. Similarly, the force and direction of the relations between these phenomena are ambiguous. Therefore, it is necessary to conduct further research on them and, as it has been shown, the model proposed by the author seems to be a good concept and a starting point for further works.

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SHORT-TERM FORECASTS OF THE DOMESTIC STEEL PRODUCTION VOLUME AND THE PROPORTION BETWEEN PRODUCTION IN THE INTEGRATED AND ELECTRIC PROCESS

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Abstract: Forecasting is an element of the decision-making process through which a desired vision of the future status of the company is worked out and determines the techniques of achieving it. Creating forecasts is a conscious action and it is based on a certain method. Statistical-econometric methods were used in this publication. The projections concerned steel production and the proportion between the applied technologies. The research covered the domestic steel industry. Due to the time span of the projections, which was assumed until 2020, the designated forecasts were acknowledged as short-term projections.

Keywords: forecast, steel production, integrated process, electric furnaces.

1. Introduction

Enterprises in a dynamic environment forecast changes concerning a lot of different areas of activity. When planning measures it is necessary to evaluate the set of problems and actions which offer an opportunity to reach the desired results. Forecasting is a part of the planning process. Forecasting means becoming involved in the future to undertake proactive measures. Looking ahead enables to answer the question: "What will happen?" and/or " What analyzed volumes will change?". Forecasting makes sense only if it covers a big set of empirical data respectively. In case of projecting or forecasting, extrapolation or interpolation is used based on numerous statistical-econometric methods. The choice of methods is left to the discretion of the researcher. For the purposes of this publication statistical methods were verified and those were chosen which were characterized by the smallest prognostic error.

The goal of this publication was to work out statistical short-term forecasts of the steel production volumes until 2020 broken down by steel production in accordance with the applied production technologies. The study was drawn up on the basis of statistical data. For creating the forecast, data on the total steel production volume, including basic converter and electrical steel from 2000 until 2015 were used. Ex-ante forecasts were made for the period

from 2016 until 2020 – a five-year period. A crawling trend model – forecasting via the harmonic balance method was worked out for the studied phenomena in the domestic steel industry.

2. A methodical procedure in projecting the steel production volume in total and according to the production processes

In order to build a forecast of the steel production volume in total and according to a breakdown by respective technologies applied in the steel industry in Poland until 2020 (5 years), adaptive and econometric models (linear, non-linear and including autocorrelation) were used. Two paths of methodical procedure were assumed. The first methodical procedure was the following: Stage 1 Creating a forecast for the entire steel production. Stage 2a1. Creating a forecast for steel production through the converter process. Stage 2a2. Forecast assessment for steel production through the electric process. The second methodical procedure, in turn, covered: Stage 1. Creating a forecast for the entire steel production. Stage 2b1. Creating a forecast for steel production through the electric process. Stage 2b2. Forecast assessment for steel production through the converter process. The adopted methodical procedure resulted from the fact that the steel obtained through the converter and electric processes made up the total steel production.

For the respective statistical methods used in the course of making projections the minimum value of one of the errors was adopted as the basis for the optimization of the point prediction value: the square root calculated from the mean squared error of the RMSE* simulated forecasts and the mean value of the relative error of the expired forecasts (Pawłowski, 1973, 1982; Sadowski, 1997). Among the tested prognostic methods optimum forecasts were chosen, taking into consideration the above-defined criteria for such exploration. The best method from among the set of optimum methods was chosen. It was the crawling trend method using the harmonic balance method. Table 1 contains a set of optimal methods used in the aforementioned research with respect to the steel production volume forecast. The methodical procedure, the verification of respective statistical methods were repeated with respect to steel production using the converter and electric processes.

Table 1.
A set of optimal prognostic methods for the explored forecast areas[1]

No.	Method or forecast model	Ex post error		Ex ante error	Comments with respect to the model parameters
		Projection of the total steel production			
		Ψ	RMSE*	Ψ	
1.	**The crawling trend method- forecasting via the harmonic balance method**	**0.044**	**0.521**	0.0230	Number of elements in the segment k = 4
2.	Autoregressive (AR) models (1,2,4,5)	0.061	0.692	0.0190	AR Model (1, 2, 4, 5)
3.	Autoregressive (AR) models (1,4,5)	0.066	0.703	0.0065	AR Model (1, 4, 5)
4.	Holt-Winters additive method (for different actuation mechanisms)	0.088	0.911	0.1092	Min. value: Ψ; $\alpha = 0.0001$; $\beta = 0.2398$; $\Phi = 0.2597$
5.	Holt-Winters additive method (for different actuation mechanisms)	0.088	0.911	0.1124	Min. value *RMSE $\alpha = 0.0001$; $\beta = 0.2395$; $\Phi = 0.2569$
6.	Line model (for illustrative purposes)	0.089	0.924	0.0914	$R2 = 0.1521$; $p = 0.1340$
		Converter steel production forecast			
No.	Method or forecast model	Ex post error		Ex ante error	Comments with respect to the model parameters
		RMSE*	Ψ	Ψ	
1.	**The crawling trend method- forecasting via the harmonic balance method**	**0.059**	**0.379**	0.0046	Number of elements in the segment k = 4
2.	Autoregressive (AR) models (1)	0.124	0.772	0.0499	AR Model (1)
		Forecasting steel production through the electric process			
No.	Method or forecast model	Ex post error		Ex ante error	Comments with respect to the model parameters
		RMSE*	Ψ	Ψ	
1.	Autoregressive models	0.039	0.171	0.0340	AR Model (1, 2, 6) $R2 = 0.7340$
2.	**The crawling trend method- forecasting via the harmonic balance method**	0.041	0.172	0.0615	Number of elements in the segment k = 4

The ex-ante error was set for 2015.

3. Steel production and the proportions between production through the integrated and the electric process

Steel, despite the development of competitive materials, is continuously classified as a basic construction material. The production of steel has dynamically increased in recent years. In 2004 it exceeded 1 billion tonnes (World Steel in Figures, 2005). 1.592 billion tonnes were produced across the world in 2015. However, due to the excess capacity there was a drop in production by ca. 2% in 2015 compared to the previous year (World Steel in Figures, 2015). The global excess capacity amounted to 700 million tonnes (The Polish Steel Industry, 2016,

p. 18). The world markets are gradually experiencing a sluggish growth of the Chinese economy. The drop in the demand of steel was reported ld steel-consuming sectors (construction, automotive industry, transport, domestic appliances). Over the long-term the situation on the world steel market shows an upward trend, with a slight drop in 2015. Since 1995 the average production growth rate has been positive. According to the data of the World Steel Association, the growth in the years 1995-2000 amounted to 2.5%, in the consecutive years: 2001-2005 a growth of 6.2% was recorded, in the next years the growth amounted to 4.5% and in the years 2010-2014 the increase was lower, ie. 3.8% (World Steel in Figures, 2015).

In Europe production had a growing trend until 2008. The greatest amount of steel in Europe was produced in 2007-210 million tonnes. After the occurrence of the effects of the world economic crisis, the steel production trend in the EU countries showed fluctuations. In 2015 2% less steel was produced in Europe than in the previous year (in 2014 steel production amounted to 168 million tonnes) (European Steel in Figures, 2007/2011; European Steel in Figures, 2008/2012).

In Poland since 2008 steel production has not exceeded 10 million tonnes. 9.2 million tonnes of steel were produced in Poland in 2015 (growth compared to the previous year by 8%) at a production capacity of 73% (The Polish Steel Industry, 2016, p. 18). The highest production volume in the last decade was reported in 2007-10.7 million tonnes (Gajdzik, 2013).

Nowadays, steel is melted in converters (integrated process: blast furnace, converters, CSC – Continuous Steel Casting) and in electric furnaces (first of all arc furnaces). The state of technological development projected by experts for the set year 2050 will not change significantly, the mentioned technologies are considered to be essential (basic) in the metallurgical sector (Paduch, and Szulc, 2014, p. 3-11). In Poland there are two converter plants (converters of the type TBM –Thyssen Blast Metalurgie, LD – Linz-Donawitz), one in Cracow and one in Dąbrowa Unit of ArcelorMittal Poland. A technological process is a combination of converters with continuous steel casting. The other mills use electric furnaces. Among the advantages of this technology is the use of mainly collected (post amortization) steel scrap (the basic iron-bearing material) and steel scrap from post-production wastes of the mills for smelting of steel and a lower energy intensity as compared with the process of producing steel in integrated mills (in the blast furnace – oxygen converter system) (Łędzki, Zieliński, and Klimczyk, 2010, p. 7-14). The steel production technology in the electric furnaces is defined as EAF - Electric Arc Furnace and in converters as BOF – Basic Oxygen Furnace.

Until 2002 the mills in Poland also used open-hearth furnaces. However, the technology was discontinued for economic and environmental reasons. In Poland more steel is produced through the integrated process, rather than the electric process, although reverse situations occurred (such a situation occurred in the years 2009-2010 and was caused by the shut-down

of redundant production capacities in integrated mills) (Gajdzik, 2013, p. 154-179). Currently (data from 2015) 58% of steel is produced through the converter process and 42% through the electric process (The Polish Steel Industry, 2016, p. 18). In the EU countries (27 countries) these proportions are slightly higher, as 61% constitutes converter steel and 39% of steel is melted in electric furnaces. The production of steel produced in Poland indicates a ca. 3% lower share of steel produced through the converter process compared with the European Union and a ca. 17% lower share with regard to world production. Converter steel in the world constitutes over 75% of the total production (table 2) (Szulc, 2014).

Table 2.
Examples of shares of converter and electric steel in the overall steel production

Specification	Poland [%]				EU [%]				The world [%]			
	2005	2010	2012	2015	2005	2010	2012	2015	2005	2010	2012	2015
The share of converter steel	58.7	49.9	50.5	58.0	61.1	58.7	58.4	61.0	65.3	65.2	70.5	75.0
The share of electric steel	41.3	50.1	49.5	42.0	38.9	41.3	41.6	39.0	34.7	34.8	29.5	25.0

Source: Compiled on the basis of data: World Steel in Figures, 2006, 2011, 2013, 2015, worldsteel Association; European Steel in Figures 2007/2011, 2008/2012 EUROFER; Polish Steel Industry, Metallurgical Chamber of Industry and Commerce, Katowice, 2006, 2011, 2013, 2016.

Apart from the overall converter and electric technology, steel production using open-hearth furnaces is still indicated. The share of open-hearth processes in the total steel production in the world is insignificant (in 2015 it constituted barely 0.3%) (World Steel in Figures, 2015). In the European Union the open-hearth technology is a historical technology (displayed in the statistical statements for the last time in 2010 at a level of 0.655 million tonnes) (World Steel in Figures, 2011).

4. The time history analysis of the total steel production and according to the production processes in Poland

On the basis of statistical data (table 3) the time history of the following examined volumes: overall steel production, steel production through the converter and electric processes was presented. The analyzed volumes were presented in the years 2000-2015.

Table 3.
Steel production in total and according to processes in the years 2000-2015

NO.	Year	Overall steel production [million tonnes]	Converter process [million tonnes]	Electric process [million tonnes]
1	2000	10.498	6.800	3.285
2	2001	8.809	5.823	2.809
3	2002	8.367	5.799	2.561
4	2003	9.107	6.070	3.037

5	2004	10.578	6.858	3.721
6	2005	8.336	4.893	3.443
7	2006	9.992	5.766	4.225
8	2007	10.631	6.198	4.433
9	2008	9.727	5.225	4.502
10	2009	7.128	3.236	3.893
11	2010	7.993	3.995	3.998
12	2011	8.776	4.424	4.353
13	2012	8.348	4.227	4.132
14	2013	7.950	4.399	3.551
15	2014	8.558	5.067	3.491
16	2015	9.202	5.323	3.879

Source: Polish Steel Industry. Annual reports of the Metallurgical Chamber of Industry and Commerce in Katowice; access: www.hiph.org/polski_przemysl_handlowy.

In the years 2000-2002 steel in Poland was produced through the open hearth furnace (grey colour in table 3), yet its share was not significant (in the years 2000, 2001, 2002, steel production through the open hearth process in Poland amounted respectively to: 0.0413%, 0.0177% and 0.0072%).

The time history of the analyzed phenomena was presented in fig. 1. In general, the course of a series of examined phenomena is difficult because of the construction of a credible forecast – there are high random fluctuations (usually cyclical fluctuations). It is not possible to identify the seasonal (cyclical) fluctuations in the analyzed volumes. In case of the steel production volume a slightly declining trend is noticeable. The production of converter steel until 2009 showed a slightly declining trend and in the years 2009-2015 a growing trend. A reverse situation was reported in case of steel production in electric furnaces. A growing trend until 2009, a declining trend in two consecutive years and a growing trend once more. In fig. 1 situations were also highlighted when in the years 2009-2010 the production of converter steel had a smaller share in the overall steel production than electric steel.
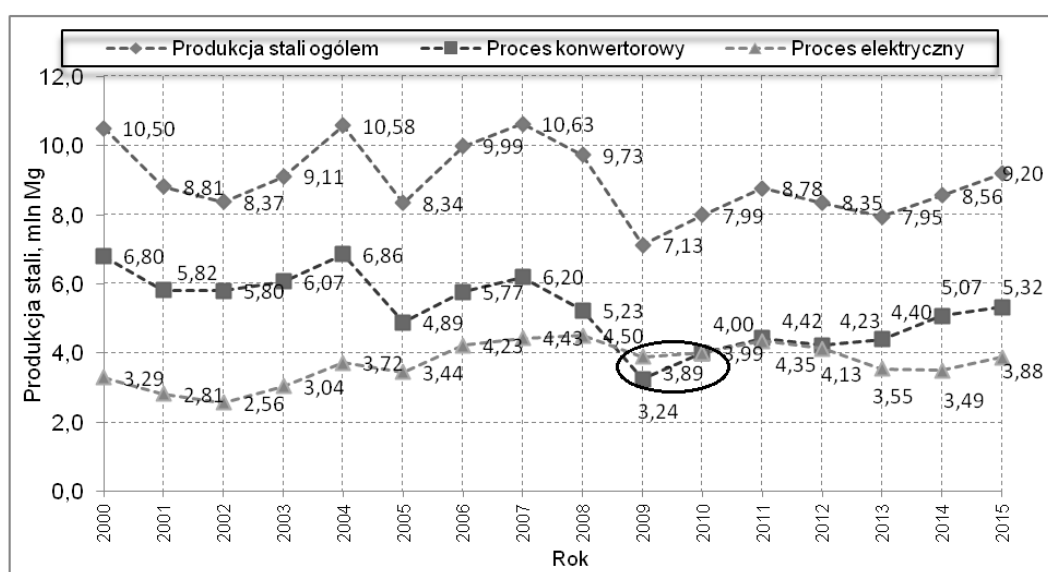

Figure 1. Steel production in total and according to production processes in the years 2000-2015. Source: own elaboration on the basis of statistical data (HIPH publications).

Most steel is produced in the steel enterprise ArcelorMittal Poland. The enterprise produces about 5 million tonnes of steel annually. 5.2 million tonnes of steel was produced in the enterprise in 2015, what constitutes nearly 55% of the overall steel production in Poland (Our steel, Your world, 2016, p. 26). The enterprise ArcelorMittal Poland produces steel through the converter process. More than 70% of steel produced in the steel enterprise is manufactured in the unit in Dąbrowa Górnicza (former Katowice Mill) and less than 30% in the unit in Cracow (former T. Sendzimir Mill) (table 4). The following mills use the electric furnace steelmaking technology: ArcelorMittal Warszawa S.A. (former Warsaw Mill) (15.7% in the overall electric steel production); CMC Poland Sp. z o.o. (former Zawiercie Mill) (29.8%); Celsa "Huta Ostrowiec" Sp. z o.o. (34.5%); Ferrostal Łabędy Sp. z o.o. (Łabędy Mill) (10.9%); Quality Steel Mill (5.8%) and ISD Częstochowa Mill (0.6%) (table 4).

Table 4.
The share of respective producers in the steel production using the converter and electric process

Enterprise	year 2012	year 2013	year 2014	Share in the overall production
	[tonnes]	[tonnes]	[tonnes]	[%]
Steel industry/steel production through the converter process in total	4 226 542	4 399 432	5 066 954	100
ArcelorMittal Poland	4 226 542	4 399 432	5 066 954	100
ArcelorMittal Poland Unit in Dąbrowa Górnicza	3 028 562	3 057 934	3 719 497	73.4
ArcelorMittal Poland Unit in Cracow	1 197 980	1 341498	1 347 457	26.6
Steel industry/steel production through the electric process in total	4 131 618	3 550 904	3 491 464	100
ArcelorMittal Warszawa S.A.	568 322	554 970	547 870	15.7
Celsa "Huta Ostrowiec" Sp. z o.o.	1 196 560	1 023 458	1 204 066	34.5
CMC Poland Sp. z o.o.	1 424 047	1 274 089	1 038 817	29.8
Ferrostal Łabędy Sp. z o.o.	303 810	324 645	381 477	10.9
Quality Steel Mill	159 052	181 049	200 925	5.8
ISD Częstochowa Mill	394 440	95 987	20 746	0.6

Source: HIPH.

5. Forecasting changes in the steel production volume in total and according to production processes – crawling trend model – forecasting via the harmonic balance method

In the course of forecasting changes in the analyzed phenomenon, the crawling trend model was combined with the projection via the harmonic balance method.

Assumptions:
1. Segments were chosen after k = 4 observations.
2. Weights or coefficients taking account of the information obsolescence were calculated according to the formula:

$$C_{t+1}^{n} = \frac{1}{n-1} \cdot \sum_{i=1}^{t} \frac{1}{n-1}.$$

Ex-ante projections were calculated according to the formula:

$$y_T^{*} = y_n + (T-n) \cdot (\sum_{t=2}^{n} w_t \cdot c_t) \quad dla \quad T = n+1, \dots, \tau.$$

The obtained modelling results were presented in the charts. As an example, the results of the overall steel production volume forecast until 2020 were provided in table 5.

Table 5.
Projecting changes in the overall production volume [million tonnes]

				Wartości modelowe Y w poszczególnych segmentach k=4														Estymatory parametrów trendu liniowego dla podokresów		Wt przyrosty	Ct-wagi harmoniczne		Wt*Ct	$\frac{	y_t - y_t^{*}	}{y_t}$	$(y_t - y_t^{*})^2$
LP	Rok	Produkcja stali ogółem	y*t	1	2	3	4	5	6	7	8	9	10	11	12	13	Segm.				Składniki	Wagi			
1	2000	10,498	9,888	9,9													1	-0,46	932,8						
2	2001	8,809	8,867	9,4	8,3												2	0,60	-1201,8	-1,0204	0,0044444	0,004444	-0,004534	0,007	0,003
3	2002	8,367	8,923	9,0	8,9	8,9											3	0,14	-266,7	0,0556	0,0047619	0,009206	0,000512	0,066	0,309
4	2003	9,107	9,123	8,5	9,5	9,0	9,4										4	0,04	-72,7	0,2000	0,0051282	0,014335	0,002866	0,002	0,338
5	2004	10,578	9,596		10,1	9,2	9,5	9,6									5	0,18	-353,6	0,4731	0,0055556	0,019890	0,009410	0,093	0,565
6	2005	8,336	9,393			9,3	9,5	9,8	8,9								6	0,48	-956,1	-0,2034	0,0060606	0,025951	-0,005278	0,127	1,117
7	2006	9,992	9,941				9,6	10,0	9,4	10,8							7	-0,95	1915,1	0,5483	0,0066667	0,032617	0,017885	0,005	0,003
8	2007	10,631	10,090					10,2	9,9	9,8	10,4						8	-1,05	2120,2	0,1488	0,0074074	0,040025	0,005955	0,051	0,293
9	2008	9,727	9,347						10,4	8,9	9,4	8,7					9	-0,20	407,9	-0,7427	0,0083333	0,048358	-0,035914	0,039	0,145
10	2009	7,128	8,048							7,9	8,3	8,5	7,4				10	0,44	-885,1	-1,2994	0,0095238	0,057882	-0,075211	0,129	0,845
11	2010	7,993	7,947								7,3	8,3	7,8	8,4			11	-0,06	120,2	-0,1002	0,0111111	0,068913	-0,006907	0,006	0,002
12	2011	8,776	8,313									8,1	8,3	8,3	8,6		12	-0,11	220,1	0,3657	0,0133333	0,082326	0,030107	0,053	0,215
13	2012	8,348	8,367										8,7	8,2	8,5	8,0	13	0,32	-629,9	0,0536	0,0166667	0,098993	0,005309	0,002	0,000
14	2013	7,950	8,299											8,2	8,4	8,4				-0,0683	0,0222222	0,121215	-0,008278	0,044	0,121
15	2014	8,558	8,462												8,3	8,7				0,1634	0,0333333	0,154549	0,025257	0,011	0,009
16	2015	9,202	8,990													9,0				0,5284	0,6666670	0,221215	0,116901	0,023	0,045
17	2016		9,280																				0,078080	0,044	0,521
18	2017		9,358																					ψ	RMSE*
19	2018		9,437																						
20	2019		9,515																						
21	2020		9,593																						

The following steel production volumes were set on the basis of the crawling trend model with the projection via the harmonic balance method: 9.280 million tonnes in 2016; 9.358 million tonnes in 2017; 9.437 million tonnes in 2018; 9.515 million tonnes in 2019 and 9.593 million tonnes in 2020. The projected steel volume indicates a slightly growing trend (fig. 2).
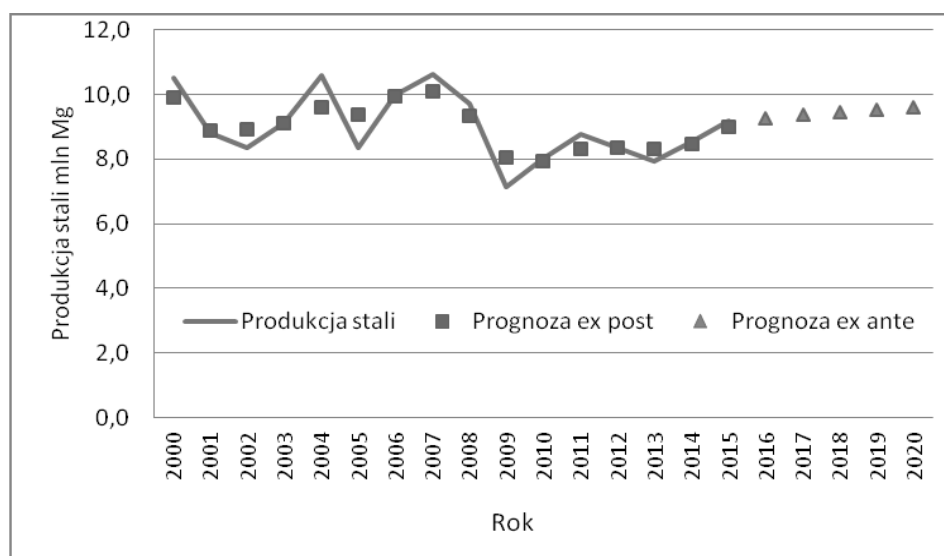

Figure 2. The projections of the overall steel production volume until 2020. Source: own elaboration on the basis of the research methodology presented in the publication.

The following levels were obtained when projecting the steel production volume through the converter process: 5.433 million tonnes in 2016; 5.542 million tonnes in 2017, 5.652 million tonnes in 2018; 5.761 million tonnes in 2019; 5.871 million tonnes in 2020. Percentage shares of steel production through the converter process in the overall steel production were listed in table 6. Figure 3 shows trends in the designated forecast – it is also a growing trend.

Figure 3. Projections of the steel production volume through the BOF converter process until 2020. Source: own elaboration on the basis of the research methodology presented in the publication.

Table 6.
Proportions between production in converter and electric furnaces

Year	Steel production through the converter process [%]	Steel production through the electric process [%]
2000	64.7	31.3
2001	66.1	31.9
2002	69.3	30.7
2003	66.6	33.4
2004	64.8	35.2
2005	58.7	41.3
2006	57.7	42.3
2007	58.3	41.7
2008	53.7	46.3
2009	45.4	54.6
2010	49.9	50.1
2011	50.4	49.6
2012	50.6	49.4
2013	55.3	44.7
2014	59.2	40.8
2015	57.8	42.2
2016	58.5	41.5
2017	59.2	40.8
2018	59.9	40.1
2019	60.5	39.5
2020	61.2	38.8

The projections of the steel production volume through the electric process are the following: 3.850 million tonnes in 2016; 3.820 million tonnes in 2017, 3.790 million tonnes in 2018; 3.761 million tonnes in 2019; 3.731 million tonnes in 2020. Percentage shares of steel production through the electric process in the overall steel production were listed in table 6. Figure 4 shows trends in the designated forecast – It is a slightly declining trend. A slight drop in the production of steel in electric furnaces may be caused by the reduction in the production capacity of the mills. The Polish steel market has already suffered sharp declines in steel production through the electric processes, eg. in 2012 ISD Częstochowa Mill produced 394 440 tonnes of steel and two years later 20 746 tonnes (drop by 95%).
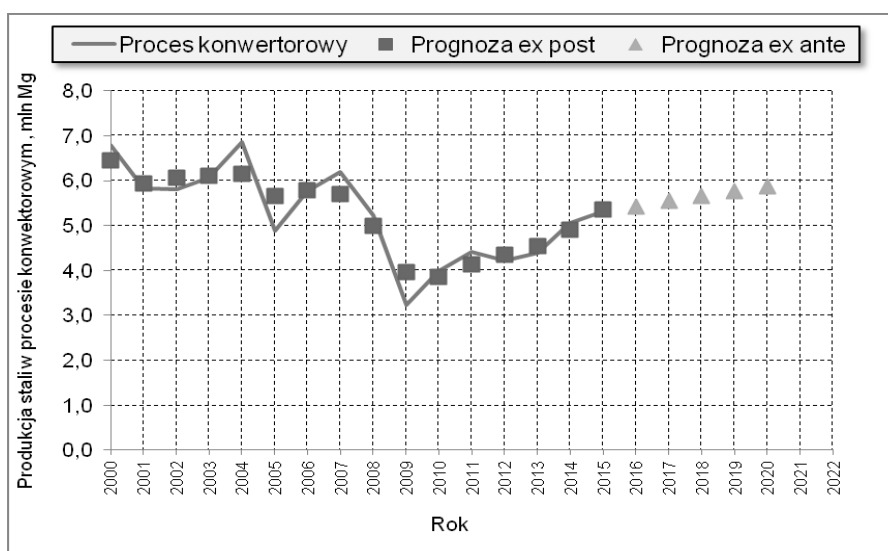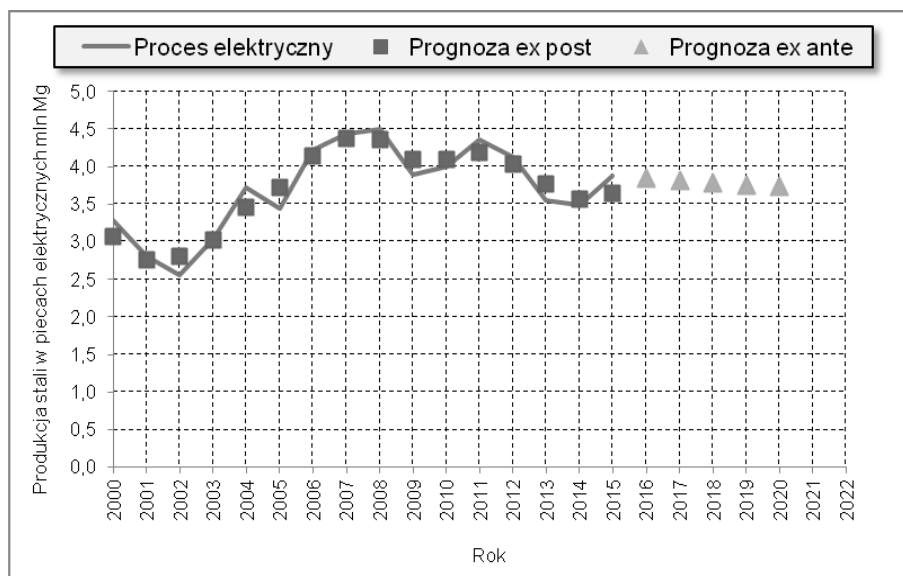

Figure 4. Projections of the steel production volume through the electric (EAF) process until 2020. Source: own elaboration on the basis of the research methodology presented in the publication.

The obtained results of all forecasts – crawling trend model with the projection via the harmonic balance method were listed in table 7.

Table 7.
Summary of the obtained forecasts of the steel production volume in total and according to technological processes

Year	Projected steel production volume in total [million tonnes]	Projected steel production volume through the converter process [million tonnes]	Projected steel production volume through the electric process [million tonnes]
2016	9.280	5.433	3.850
2017	9.358	5.542	3.820
2018	9.437	5.652	3.790
2019	9.515	5.761	3.761
2020	9.593	5.871	3.731

Source: own elaboration on the basis of the research methodology presented in the publication.

6. The projected steel production volume according to processes in available studies

The steel production volume forecast was carried out by the Polish Electricity Association (PKEE) (Report 2030, 2008)[2]. On the basis of the worked out scenarios, the steel production does not exceed the current production capacity and the proportions between production in electric furnaces (EAF) and converter furnaces are slightly changing in favour of production in electric furnaces (table 8). The forecasts were carried out in 2007, assuming empirical evidence based on the production of steel in the years 1996-2006 (table 8). The forecasts of the steel production volume and the proportion between production in electric and converter furnaces were determined until 2030. Two scenarios were developed on the basis of data: the baseline and the moderate scenario (table 8).

Table 8.
Forecasts of the steel production volume and the proportion between production in converter and electric (arc) furnaces

Year	Statistics		Baseline				Moderate			
	BOF Steel [million tonnes]	EAF Steel [million tonnes]	BOF Steel [million tonnes]	BOF Steel [%]	EAF Steel [million tonnes]	EAF Steel [%]	BOF Steel [million tonnes]	BOF Steel [%]	EAF Steel [million tonnes]	EAF Steel [%]
1996	6.757	2.554								
1997	7.531	2.994								
1998	6.223	3.143								
1999	5.452	3.022								
2000	6.794	3.290								
2001	5.823	2.809								
2002	5.799	2.561								
2003	6.070	3.037								
2004	6.858	3.721								
2005	5.001	3.443								
2006	5.766	4.242								
2010	Forecasts		7.000	58.3	5.000	41.7	6.200	59.6	4.200	40.4
2015	Forecasts		7.200	55.4	5.800	44.6	6.300	59.4	4.300	40.6
2020	Forecasts		7.400	53.6	6.400	46.4	6.400	57.2	4.800	42.8
2025	Forecasts		7.400	52.1	6.800	47.9	6.500	56.5	5.000	43.5
2030	Forecasts		7.400	51.4	7.000	48.6	6.600	56.9	5.000	43.1

Report 2030: The impact of the proposed EU regulations in terms of implementing the European development strategy of CO2-free energy production on Poland's energy safety and, in particular, the options to restore generation capacities using fossil fuels and the prices of electricity. App. 2. Assumptions concerning the levels of activity and energy intensity of distinguished types of production or services, Warsaw, June 2008. The study was carried out by the company Badania Systemowe EnergoSys on behalf of PKEE, access: www.toe.pl/plwybrane-dokumenty/rok-2008?download=455:załącznik-2.

Because the forecast was evaluated in 2007, it is possible to refer the projected volumes from the years 2010 and 2015 to the actual production (table 9). This summary will enable to

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[2] The study was carried out by the company Badania Systemowe EnergoSys on behalf of PKEE. Retrieved from www.toe.pl/plwybrane-dokumenty/rok-2008?download=455:załącznik-2.

determine the differences between the projected and actual volumes. The obtained (positive) differences are evidence of overestimated volumes of the forecast in the considered scenarios. In case of the baseline scenario, the dynamics of changes is greater than in the moderate scenario. Assuming that the indicators of the dynamics of changes are forecast errors, the volumes in forecasts for 2020 and the next years were verified (table 10). The dynamics of changes was calculated according to the following formula:

$$Dz = \frac{Pz - Wr}{Pz} \, x \, 100\%$$

where:
Dz – indicator of the dynamics of changes,
Pz – projected volumes of the analyzed phenomenon,
Wr – actual volume.

Table 9.
Differences between the projected and actual volumes in the overall steel production volume and in the technological processes

No.	Specification	2010	Indicator of the dynamics of changes	2015	Indicator of the dynamics of changes
1	Baseline – forecast of the volume of produced steel in total [million tonnes] (projected volume of the analyzed phenomenon)	12.000	-	13.000	-
2	Actual volumes of produced steel [million tonnes] (actual volume)	7.993	-	9. 202	-
Difference between the projected and actual volumes [million tonnes] (1-2)		4.007	33.39%	3.798	29.21%
3	Baseline – forecast of the volume of produced steel in the BOF technology [million tonnes] (projected volume of the analyzed phenomenon)	7.000	-	7.200	-
4	Actual volumes of produced steel in the BOF technology [million tonnes] (actual volume)	3.995	-	5.323	-
Difference between the projected and actual volumes [million tonnes] (3-4)		3.005	42.92%	1.877	26.06%
5	Baseline – forecast of the volume of produced steel in the EAF technology [million tonnes] (projected volume of the analyzed phenomenon)	5.000	-	5.800	-
6	Actual volumes of produced steel in the EAF technology [million tonnes] (actual volume)	3.998	-	3.879	-
Difference between the projected and actual volumes [million tonnes] (5-6)		1.002	20.04%	1.921	33.12%
7	Moderate scenario – forecast of the volume of the produced steel in total [million tonnes] (projected volume of the analyzed phenomenon)	10.400	-	10.600	-
8	Actual volumes of produced steel [million tonnes] (actual volume)	7.993	-	9. 202	-
Difference between the projected and actual volumes [million tonnes] (7-8)		2.407	23.14%	1.398	13.19%
9	Moderate scenario – forecast of the volume of produced steel in the BOF technology [million tonnes] (projected volume of the analyzed phenomenon)	6.200	-	6.300	-

10	Actual volume of produced steel in the BOF technology [million tonnes] (actual volume)	3.995	-	5.323	-
	Difference between projected and actual volumes [million tonnes] (9-10)	2.205	35.56%	0.977	15.50%
11	Moderate scenario – forecast of the volume of produced steel in the EAF technology [million tonnes] (projected value of the analyzed phenomenon)	4.200	-	4.300	-
12	Actual volumes of produced steel in the EAF technology [million tonnes] (real value)	3.998	-	3.879	-
	Difference between the projected and actual volumes [million tonnes] (11-12)	0.202	4.8%	0.421	9.79%

Source: Projections from: Report 2030: The impact of the proposed EU regulations in terms of implementing the European development strategy of CO2-free energy production on Poland's energy safety and, in particular, the options to restore generation capacities using fossil fuels and the prices of electricity. App. 2. Statistical data concerning the volume of steel production from the reports: Polish Steel Industry, Metallurgical Chamber of Industry and Commerce (HIPH), Katowice.

Table 10.
Verified projections of the value of steel production in total and according to production technology

No.	Specification	Indicator of the dynamics of changes*	2020		2025		2030	
			Projected volume of the analyzed phenomenon	Projected volume of the analyzed phenomenon*	Projected volume of the analyzed phenomenon	Projected volume of the analyzed phenomenon*	Projected volume of the analyzed phenomenon	Projected volume of the analyzed phenomenon*
1	Baseline – forecast of the volume of the produced steel in total [million tonnes]	33.39%	13.800	9.192	14.200	9.459	14.400	9.592
		29.21%		9.769		10.052		10.194
2	Baseline – forecast of the value of produced steel in the BOF technology [million tonnes]	42.92%	7.400	4.224	7.400	4.224	7.400	4.224
		26.06%		5.471		5.471		5.471
3	Baseline – forecast of the volume of produced steel in the EAF technology [million tonnes]	20.04%	6.400	5.117	6.800	5.437	7.000	5.5972
		33.12%		4.280		4.548		

4	Moderate scenario – forecast of the volume of produced steel in total [million tonnes]	23.14%		8.608		8.839		8.916
		13.19%	11.200	9.723	11.500	9.983	11.600	10.070
5	Moderate scenario – forecast of the volume of produced steel in the BOF technology [million	35.56%		4.124		4.189		4.253
		15.50%	6.400	5.408	6.500	5.492	6.600	5.577
6	Moderate scenario – forecast of the volume of produced steel in the EAF technology [million	4.8%		4.570		4.760		4.760
		9.79%	4.800	4.330	5.000	4.510	5.000	4.510

* dynamics indicators from table 9 for the years 2010, 2015, Projected volume of the analyzed phenomenon*-adjusted forecast.

Source: own study.

Adjusted forecasts of PKEE (Polish Electricity Association) were referred to forecasts of the overall steel production volume and broken down by respective technological processes carried out on the basis of the crawling trend model with the projection via the harmonic balance method. The obtained results were presented in table 11.

Table 11.
Summary of the projected changes in the volume of steel production in total and according to technological processes in 2020

Specification	Crawling trend model	Baseline of PKEE (Polish Electricity Association)	Moderate scenario of PKEE (Polish Electricity Association)
Forecast of the volume of produced steel in total [million tonnes]	9.593	9.192-9.769	8.608-9.723
Forecast of the volume of produced steel in the BOF technology [million tonnes]	5.871	4.224-5.471	4.24-5.408
Forecast of the volume of produced steel in the EAF technology [million tonnes]	3.731	4.280-5.117	4.330-4.570

Source: own study.

7. Conclusions

On the basis of the summary (table 11), it can be concluded that the respective forecasts of the volume of steel produced in Poland will not exceed 10 million tonnes in 2020. According to the optimistic scenario metallurgical enterprises will produce ca. 9.7 million tonnes and according to the moderate scenario from 9.2 to 9.5 million tonnes. The pessimistic scenario assumes the production at the level of 8.6 million tonnes. The share of steel obtained through the BOF technology in the total steel production can assume two extreme scenarios: the share of this technology will still be significant (reaching even 60% of production in total) or it will drop and the share of steel obtained from electric furnaces will slightly increase. According to the second scenario, the shares of respective technologies in the total steel production will slightly differ from the current ones (table 6). It can be concluded that in 2020 in the range of the steel production technology in Poland there will not be any major changes (the present proportions shall be maintained). In the long run (projections until 2050) the increase of the share of recovered scrap from the present 45% to 70% will entail the increase of the share of the electric process in the production of steel (Paduch, and Szulc, 2014, p. 3-11). When the present proportions are reversed, the approximate 60% of steel shall not be produced through the converter process, but in electric furnaces. Reaching the proportion: 40% – integrated process and 60% – electric furnaces is dictated by ecological requirements – reduction of CO_2 emissions (the adopted proportions will reduce the CO_2 emissions from the present level of 1.8 to 0.6 tonnes per 1 tonne of steel in 2050) (Paduch, and Szulc, 2014, p. 3-11). The technological changes will also bring about energy savings – lower energy consumption from the current level of 21GJ to 8.6 GJ per tonne of steel. Within the next three years (short-term forecast until 2020) the Polish steel sector will not record any major changes. The current production capacity amounts to 13.055 million tonnes of crude steel, including 7.6 million tonnes in the integrated process.

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THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ) – APPLICATION AND IMPACT ON INNOVATION

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Abstract: This paper presents primary assumptions, origins and development of the Theory of Inventive Problem Solving (TRIZ) methodology. It also presents global application of the methodology and its impact on innovation by presenting original research into the interrelation between TRIZ implementation in a company and the increase in the number of patents obtained. Furthermore, it deals with the growing interest in TRIZ in Poland, and it describes events related to that.

Keywords: Theory of Inventive Problem Solving, TRIZ, innovation.

1. The Theory of Inventive Problem Solving

The Theory of Inventive Problem Solving (TRIZ) was developed by the Soviet inventor Henry Altshuller (1926-1998) who had devoted all his life to its development and improvement[1]. Although there is some disagreement as to the very beginnings of TRIZ, it is assumed that it was created in the. 1950s (Ikovenko, Yatsunenko, Karendał, Przymusiała, Kobyakov, Obojski, and Vintman, 2017, p. 11). Altshuller, while being employed at the Fleet Patent Office headquartered in Baku, through examination of the local patent collections discovered that both ways of creating new inventions and the number of issues arising in the course thereof are not infinite. What is more, it is possible to describe 'typical' problems mankind had faced throughout its development, and 'typical'" ways of resolving them in a relatively small number of ways. According to Altshuller, the entire surrounding world may be described as coexistence of two types of systems: natural (biological) systems and technological cal systems. Natural systems ought to be interpreted as anything created without human intervention, whereas technological systems ought to be interpreted as human creations only. However, it does not only mean technology per se, but also such elements as social organisation, or even science (Karendal, 2016, p. 154). Those were not the only laws

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[1] More information on Henry Altshuller can be found on the site of the International TRIZ Association at: https://matriz.org/about-matriz/about-founder/, 10.10.2017.

discovered by Altshuller. When conducting an extensive patent analysis, he realised all technological systems developed according to objectively existing principles, the so-called Technological System Development Principles, which needed to be rediscovered and used to develop technology and innovative tasks in a conscious manner (Altshuller, 1983, p. 35-39). Owing to the knowledge thereof, and the possibility to determine individual stages of technological systems development, it had become possible to forecast development thereof as well as to predict – in the case of technology – when a system marketing would permit the largest profit.

The TRIZ methodology as such was not confined to the foregoing discoveries. As any technological system, it also develops and evolves. At its initial stage of development, it aimed to develop an algorithm enabling technological problem solution. However, it was soon discovered that the problem solved was actually not the one to be solved. Much effort was thus put into developing tools which would enable identification of the problem that actually resulted in project failures. Upon the collapse of the Soviet Union and methodology migration to developed free market economies, TRIZ development was focused on development and application of tools enabling most efficient problem solution and product marketing. On the other hand, its latest development has focused on further product improvement. Contemporary TRIZ has become a most extensive and comprehensive methodology of pragmatic innovations, i.e. innovations benefitting their creators. Historical development of the TRIZ methodology has been presented in the following figure.
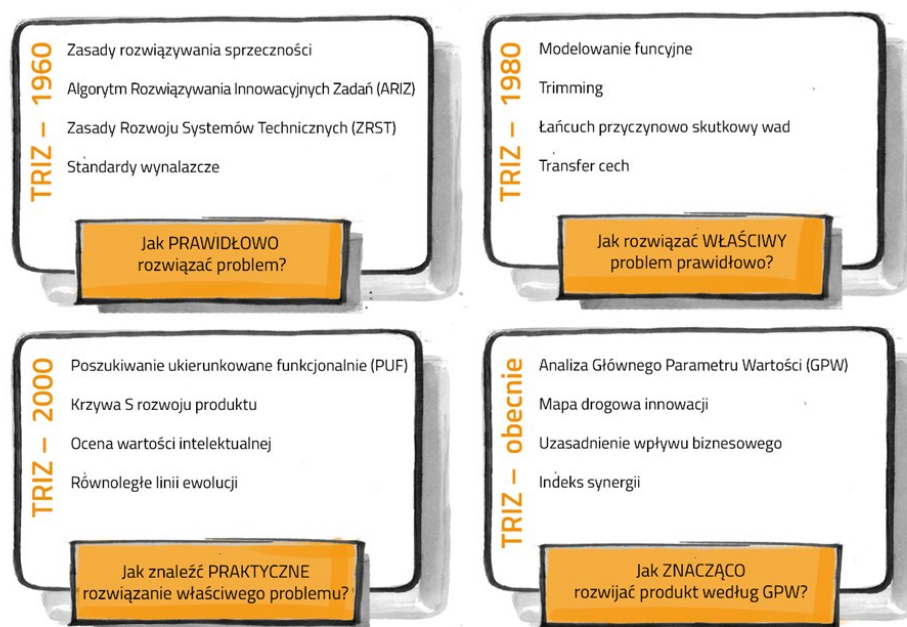

Figure 1. TRIZ development. Adapted from: "Współczesna Teoria Rozwiązywania Innowacyjnych Zadań. Podręcznik na I stopień certyfikacji Międzynarodowego Stowarzyszenia TRIZ (MA TRIZ)" by S. Ikovenko, S. Yatsunenko, P. Karendał, M. Przymusiała, S. Kobyakov, J. Obojski, Z. Vintman. Copyright 2017, p. 11.

TRIZ systematics has become a very important aspect of its contemporary methodology. No chaotic actions are conducted, and innovations are developed through carefully planned and repeatable action based on an algorithm that covers three stages: problem identification, problem solving, and solution concept justification. Each of the foregoing stages plays a crucial role, and none of them may be disregarded. Also, all the stages involve sets of different tools enabling successful completion of innovative task individual phases. When commencing problem analysis, one ought to precisely identify project objectives and measurable results, and then, using TRIZ analytical tools, identify the main reasons for the inability to succeed. Identification of the problem, or problems, to be solved is followed by stage two which uses tools designed to solve problems. Their application results in a set of model solutions which still need to be transformed into actual ideas or projects. However, solution concept development is not the end of the actions. One still needs to evaluate and select the idea most likely to succeed in the market. The list of contemporary TRIZ tools is most extensive, but this ought not to be considered a flaw. All the tools are never simultaneously used on an innovative project. They are selected based on the type and objective of a specific project (Ikovenko, Yatsunenko, Karendał, Przymusiała, Kobyakov, Obojski, and Vintman, 2017, p. 22-23).

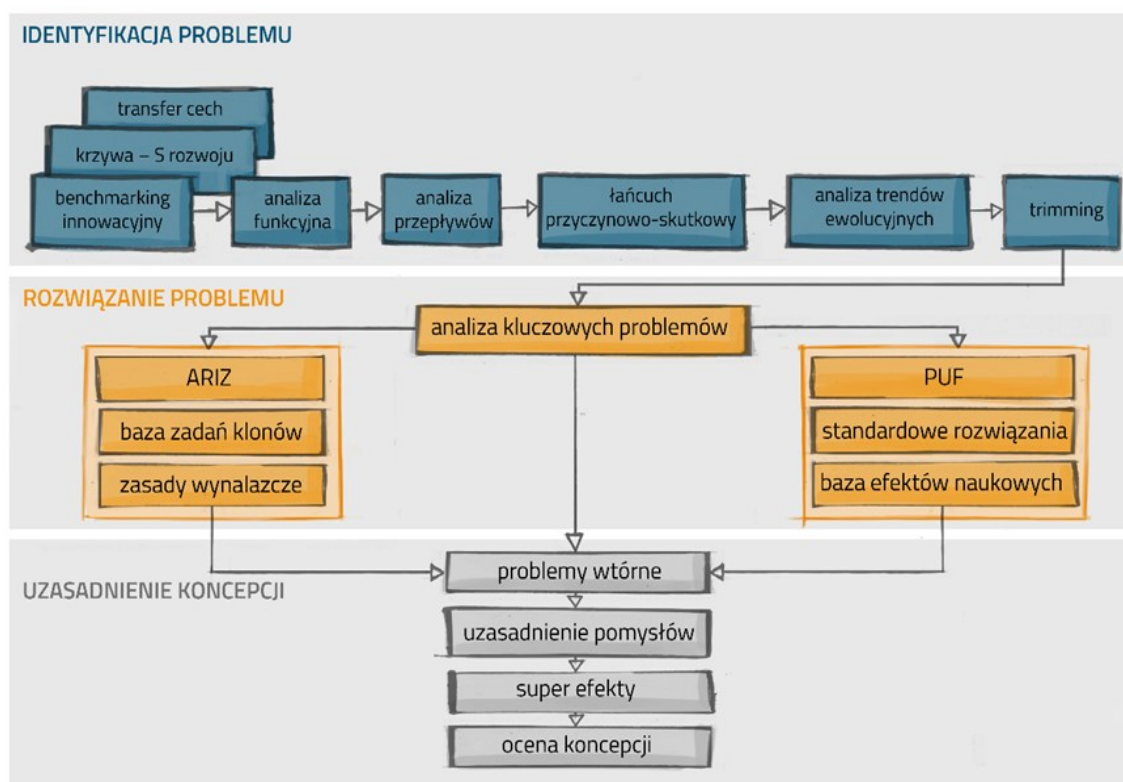A full version of the TRIZ algorithm applicable to the foregoing stages has been presented below.

Figure 2. Pragmatic Innovation Roadmap. Adapted from: "Współczesna Teoria Rozwiązywania Innowacyjnych Zadań. Podręcznik na I stopień certyfikacji Międzynarodowego Stowarzyszenia TRIZ (MA TRIZ)" by S. Ikovenko, S. Yatsunenko, P. Karendał, M. Przymusiała, S. Kobyakov, J. Obojski, Z. Vintman. Copyright 2017, p. 24.

With the development of the methodology and commencement of TRIZ popularisation outside the Soviet Union, there arose an idea of establishing an institution whose task would be to take care of the quality of the knowledge transferred as well as to set standards and new directions of development. For this reason, the International TRIZ Association (MA TRIZ) (https://matriz.org/about-matriz, 2017) was founded in 1997, and it soon became an institution bringing together all the most important TRIZ organisations from all over the world. Given that the methodology had been significantly extended, the entire TRIZ knowledge was divided by the International TRIZ Association into five levels. The first three levels of certification enable understanding and mastering of all the tools at the methodology's disposal. Knowledge is gained through training sessions conducted by MA TRIZ accredited trainers. Each of the first three stages concludes with a written examination; if one applies for a 3rd level certificate, they may be subject to an additional oral examination designed to verify the knowledge gained. Certification at the highest levels proceeds in a slightly different manner. In the case of the 4th level, one needs to demonstrate work with the methodology applied, they need to select and successfully complete a project, and they need to deliver it in written form to the MA TRIZ examination committee. If it receives a positive review, the applicant receives a 4th level certificate. However, one may not apply for this knowledge level certification without holding a 3rd level certificate. Obtaining the 5th level knowledge certificate and the *TRIZ Master* title requires the applicant's own contribution to the methodology development. However, a written paper shall not suffice. Before the applicant may obtain the highest level of methodology knowledge certificate, they need to defend their paper before a committee comprising other *TRIZ Masters* (https://matriz.org/matriz-offices/council-on-expertise-and-methodology-cem/certification/how-to-become-a-specialist, 2017). This is only possible once a year, during the TRIZ *fest* – the largest international TRIZ methodology meeting.

2. TRIZ in the world

At this point, it is worth asking how many specialists there are who can pride themselves on holding a TRIZ knowledge certificate granted by MA TRIZ. The foregoing diagram presents all the TRIZ certificates granted in the years 2008-2016 with respect to all the levels (https://matriz.org/matriz-offices/council-on-expertise-and-methodology-cem/certification/lists-of-certified-triz-specialists, 2017). 4th and 5th level certificates have been shown together due to the insignificant number thereof as compared to the other certification levels. Another problem worth clarifying is also the analysis timeframe. Given that the 2017 data is incomplete (as at November 2017), a decision was made to present data up to 2016 included.

As far as the analysis commencement date is concerned, it was related to the commencement of training activities on a large scale. Although 1st-3rd level certificates were granted before 2008, the official requirement that the certification date be entered in the MA TRIZ database had not been imposed until then. For that reason, a decision was made to select this very date. Similar is the case of higher level certificates which were also granted before 2008. For instance, Altshuller himself, before his death in 1998, granted his 65 students the highest obtainable certificates. However, in order to preserve data presentation continuity, while avoiding an excessive number of diagrams, a decision was also made to apply the original starting date of 2008.
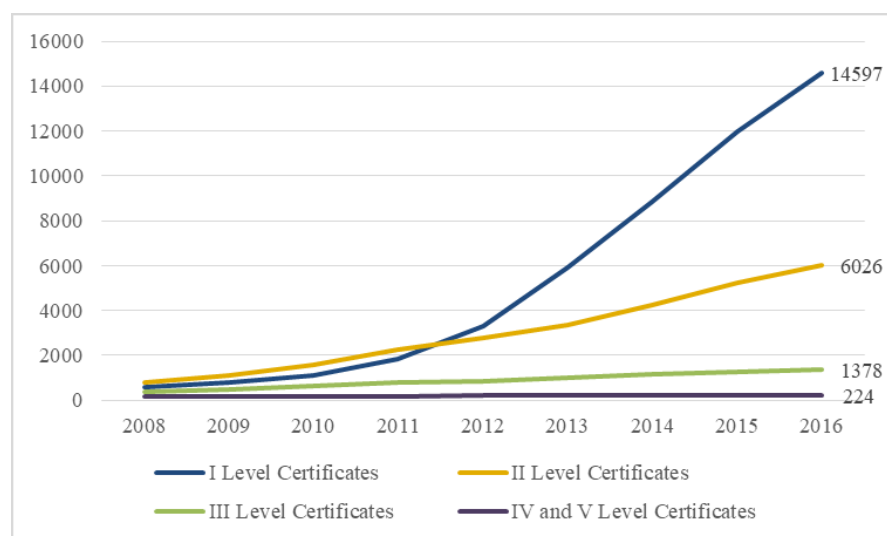

Figure 3. World I-V Level TRIZ certifications 2008-2016. Own study.

When analysing data on the number of TRIZ certifications, one may realise that the worldwide popularity of the methodology is a relatively new phenomenon. If the increase in the number of 1st level certifications only is considered, it is clear that the interest in the methodology occurred after 2012. In just four years, the number of 1st level certifications increased nearly fivefold. Similar was the situation in the case of 2nd level certifications. Since the onset of the large-scale action commenced in 2012, their number had more than doubled. An increase, be it less significant, may also be observed in the case of 3rd level certifications. The situation with the highest level certification is different, due to the fact that they are difficult to obtain, the number of professionals who can pride themselves on holding such certifications is relatively low. However, this does not change the fact that the TRIZ methodology is beginning to transform from a relatively niche science of creating innovation to an increasingly more worldwide movement.

Given the increasing interest in the TRIZ methodology, it is worth asking what purpose it may be used for? Today, it may be applied to improve existing products or processes, but also to create and develop them. Owing to the above-mentioned technological system development principles, it may also be applied to develop a specific technology and to create strategies

regarding intellectual property. It is also used to assess and verify technologies, and to identify reasons for incorrect operation of technologies. Moreover, it makes it possible to seek an adequate technology, very often – in most different fields. In recent years, it has started to be used with a view to future recycling of products developed, and to reuse of the materials used. Contemporary TRIZ is applied in numerous fields and industries. It is applied in the automotive, electronic, medical technology, optics and telecommunications industry, in the production and distribution of wide-ranging consumer goods, in the oil and energy industry, in the production and processing of metals.

3. TRIZ vs. innovation

There is no doubt that today innovation is one of the most important factors affecting global economic growth. It is because of that significant shift in the development paradigm the impact of which may be compared to the 18th century industrial revolution that the state (and – on a slightly lesser scale – the enterprise), capable of 'producing' knowledge on a large scale, may gain a crucial competitive advantage over others. It would be a huge mistake to ignore the global trend towards shifting from mass production in the so-called heavy industry to production and development of broadly interpreted technologies. Thus, growing popularity of any and all methodologies attempting to facilitate transition from the idea to the successful implementation thereof comes as no surprise.

However, it is worth asking whether the improvement idea is something completely new? It certainly isn't. What is more, there are plenty of well known creative thinking activation methods. There is no need to describe them in this paper as each reader will certainly come up with at least several of them (for instance brainstorming, analogies, or the morphological analysis). There are also more complex methodologies, for instance the *Six Sigma* methodology, or even a quality management philosophy – the *Kaizen* philosophy. All these methods and methodologies are popular throughout the world, and they are applied by the largest global enterprises. However, they are characterised by some inconvenience – they are mostly oriented at improving human skills, not the technology itself. What may it be considered a flaw? The answer is very simple: mankind evolves much slower than technology, so a method focused on technological development ought to be considered more efficient.

The need to 'focus on technology' is probably responsible for the rapid growth of interest in TRIZ all over the world. One of the TRIZ unique characteristics is the focus on development of technology and certain universal laws governing technological system evolution. TRIZ, which is also a system, has significantly developed since its formation in the

1950s. Starting as a tool the overarching objective of which was to solve a problem, it has now become an extremely effective methodology enabling identification of the correct problem, its solution in the most efficient and practical way, and – most importantly – marketing and sale of such a solution.

Although TRIZ has been around for decades, a very rapid growth of its popularity has been observed since relatively not long ago. In just three years since the statistical survey on the number of TRIZ certifications around the world (http://novismo.com/wiedza/artykuly/ ?article=triz_na_swiecie, 2017), carried out in August 2014, the number of certified TRIZ professionals has more than doubled (https://matriz.org/matriz-offices/council-on-expertise-and-methodology-cem/certification/lists-of-certified-triz-specialists, 2017). The current number of officially certified professionals around the world (status as at November 2017) is more than twenty-four thousand. It is an excellent reason to investigate the impact of the TRIZ methodology on the creation of innovations.

The most important question is how widespread implementation of the TRIZ methodology may contribute to the increase of the innovation rate? So posed a question instantly brings about two serious problems. The first of them is innovation itself, measured today with numerous indicators. Given the imperfectness of the manner adopted, this analysis will pertain to the most general and most easily measured indicator, namely the number of patents which may be considered as official acknowledgement of the new knowledge produced. The other problem is as important: how many official certifications may be considered as general implementation within a specific country or enterprise? In order to overcome this adversity, a decision was made to focus on studies into one country only, namely South Korea (https://matriz.org/matriz-offices/council-on-expertise-and-methodology-cem/certification/lists-of-certified-triz-specialists, 2017). The foregoing choice was not made by accident. If one were to name a country which has made TRIZ application one of the sources of its competitive advantages, they would need to name but the Republic of Korea. Almost 66% of the certificates of all degrees of knowledge are held by TRIZ experts from South Korea (https://matriz.org/matriz-offices/council-on-expertise-and-methodology-cem/certification/lists-of-certified-triz-specialists, 2017), so it appears that it is the most appropriate country to carry out such an analysis.
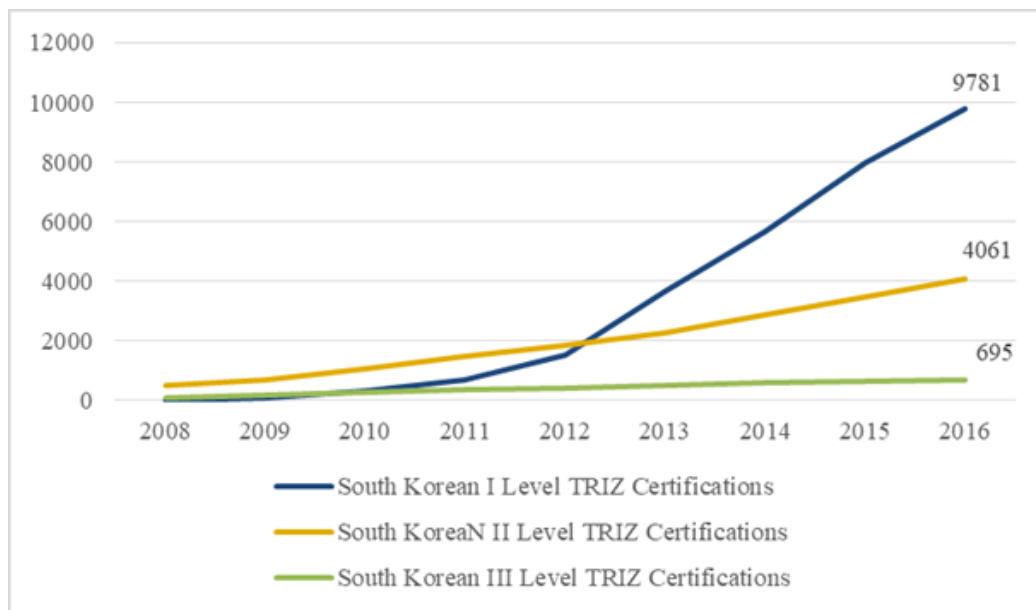
Figure 4. South Korean I-III Level TRIZ certifications 2008-2016. Own study.

The foregoing diagram shows the number of 1st-3rd level certifications obtained in South Korea in the years 2008-2016. However, in order to avoid possible misunderstanding, several issues need to be clarified. The analysis only covers the first three levels of the TRIZ certification. This is so due to the specifics of the very TRIZ training. All the methodology knowledge is obtained upon completion of the 3rd level training. Higher levels are obtained through independent work with the TRIZ methodology. Consequently, in order to measure the impact of TRIZ on innovation, it is worth focusing on professionals who have completed such training, and on their accomplishments. To some extent, this may reflect how TRIZ implementation may bring about results in a short time. What is more, the number of 4th and 5th level professionals in South Korea is rather insignificant.

It has been possible to observe a sharp increase in the number of certified TRIZ professionals from the Republic of Korea since 2010. The number began to increase even more rapidly in 2012, and there continues to be a distinct growing trend. In 2016, South Korea could pride itself on having 9,781 1st level professionals, 4,061 2nd level professionals, and 695 3rd level professionals. How does this high number of certifications affect innovativeness of the country? As it has already been mentioned, further research – a patent statistics analysis – ought to be conducted for this problem to be measured.
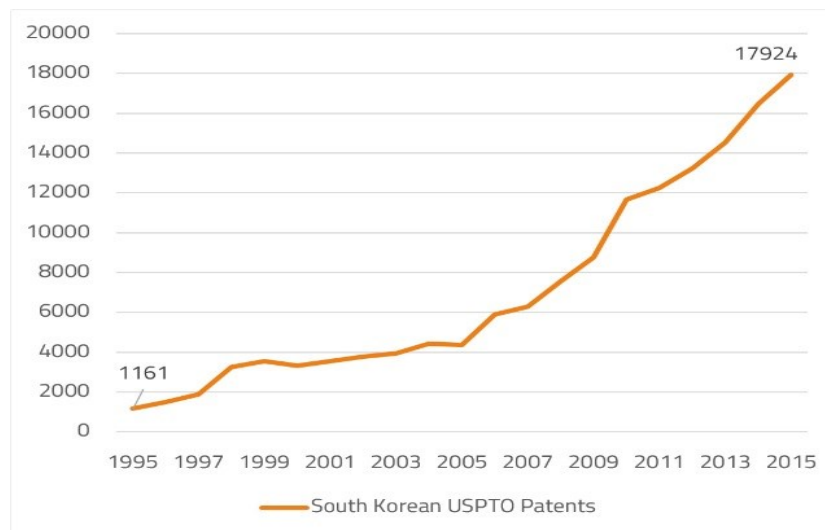
Figure 5. South Korean USPTO patents 1995-2015. Own study.

The foregoing diagram shows the number of South Korean patents registered by the United States Patent and Trademark Office (USPTO) in the years 1995-2015 (http://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports.htm#by_org, 2017). Selection of the database to be analysed ought to be clarified in this case as well. The main reason for the USPTO database selection was the position held by the United States within in the global economy – it is one of the largest markets in the world, and anyone who wants to be a major player in world economy needs to patent their solutions there. Another important factor was the detailedness of the data contained in the Patent Office of the United States database – not only does it cover patent activity of a specific country, but it also covers companies originating from individual countries, which will be of crucial importance further on in this analysis. As regards the timeframe of the analysis, similarly to the TRIZ certification, its beginning (1995) was dictated by the USPTO starting to make such statistics available, whereas 2015 was the last year in which such a collection of data was made available by the United States Patent Office (status as at November 2017).

In barely 20 years, South Korea recorded that the number of patents granted increased fifteen times – from 1,161 patent applications in 1995 to as many as 17,924 patent applications in 2015. Patent statistics clearly indicate how much the status of innovation changed in the Republic of Korea – it has become one of the most innovative countries in the world. When analysis the diagram more diligently, one may observe that the first stage of the increase could be observed back in 1997, with further and more distinct growing trends being observable in 2005 and 2007. On the other hand, it has been possible to observe an uninterrupted increase since 2010.
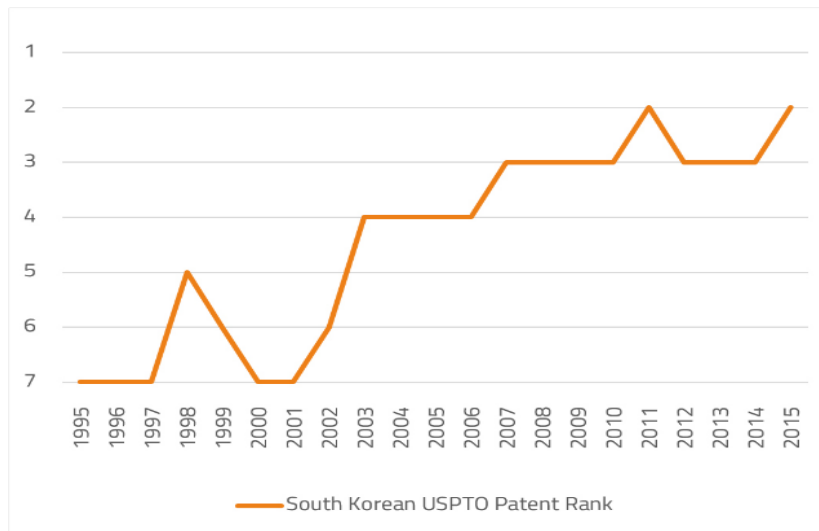
Figure 6. South Korean USPTO patent rank 1995-2015. Own study.

Given the foregoing patent rank, it may be observed that South Korea ranks second in terms of the number of patents granted in the United States.
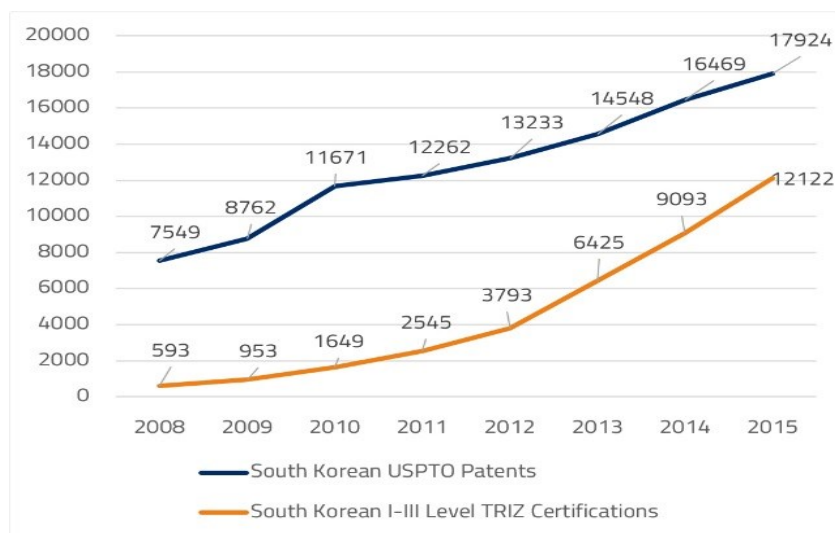

Figure 7. South Korean USPTO patents and I-III Level TRIZ certifications 2008-2015. Own study.

The foregoing diagram shows the correlation between the USPTO patents granted to South Korea and the number of TRIZ 1st to 3rd level professionals. It appears that the foregoing sharp increase in the number of patents granted may be attributed to the dynamic growth of the number of TRIZ professionals. As of 2010, we have been observing similarities between the growing number of TRIZ professionals and the number of USPTO patents obtained. Thus, a conclusion that there is a correlation between the two variables appears justified. However, it is worth noting that an analysis at the national level is definitely insufficient evidence – no country develops patent applications, or broadly interpreted innovations, just of its own accord. In order to understand what underlies the rapid growth of South Korean innovativeness, one needs to analyse its largest enterprises in a more in-depth manner.

So as to analyse the phenomenon as deeply as possible, a decision was made to focus on the three largest and most popular Korean enterprises which had incorporated TRIZ in their corporate cultures, namely Samsung Electronics, LG Electronics and Hyundai Motor. Unfortunately, there is no data that describes the exact number and the increase in the number of TRIZ professionals in a given year, within individual enterprises; however, courtesy of the former President of MA TRIZ, Professor Sergey Ikovenko, it was possible to obtain information on the onset of TRIZ implementation within the aforementioned companies.
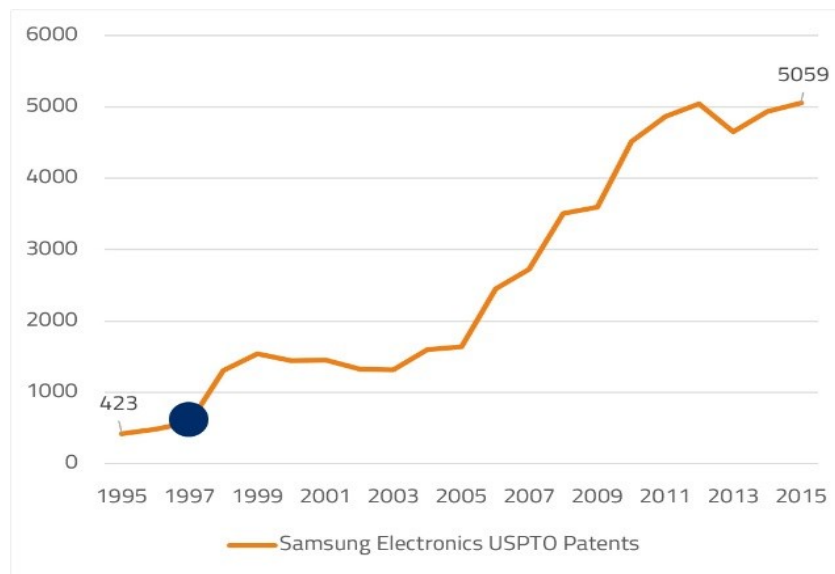

Figure 8. Samsung Electronics USPTO patents 1995-2015. Own study.

The foregoing diagram presents patents which Samsung Electronics obtained from the USPTO in the years 1995-2015. Similarly to South Korea, one may observe a huge growth of the number of patents granted in the period analysed. In that respect, Samsung recorded a nearly twelve-times increase – from 432 patents in 1995 to 5,059 patents in 2015. Patents obtained by Samsung Electronics from the United States Patent Office account for nearly 30% of all the patents obtained from the Office by South Korea. Samsung was also the very first enterprise to implement the TRIZ methodology on a large scale. The first attempts were made back in 1997, which resulted in successful execution of a few original innovation projects. Since 1998, when TRIZ was actually implemented within Samsung Electronics (http://s828-c8b.nubex.ru/file.php/id/f5767/name/6.%20Article%202.%20The%20Acceleration%20of%20 TRIZ%20Propagation%20in%20Samsung%20Electronics_ETRIA2005.pdf, 2017), the enterprise had recorded a significant, be it short-lasting, increase in the number of patents granted. Another, this time a very sharp and ongoing increase in the number of patents occurred after seven years. The gap was most probably related to the development of TRIZ itself – in recent years, a significant development thereof has been observed, and the methodology has become a tool enabling accomplishment of good results within a relatively short time.
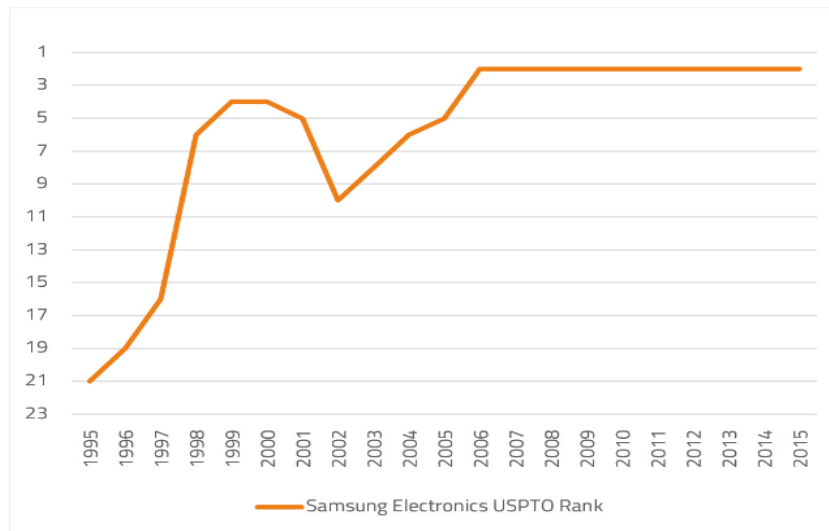
Figure 9. Samsung Electronics USPTO patent rank 1995-2015. Own study.

In order to illustrate the impact of TRIZ in the best possible manner, a decision was made to present the position held in terms of patents obtained by Samsung Electronics in the years 1995-2015; in the period analysed, the number increased much faster than within other enterprises. Starting as 21st in terms of the number of patents granted, since 2007 Samsung Electronics has ranked second, just after the American tycoon – IBM.
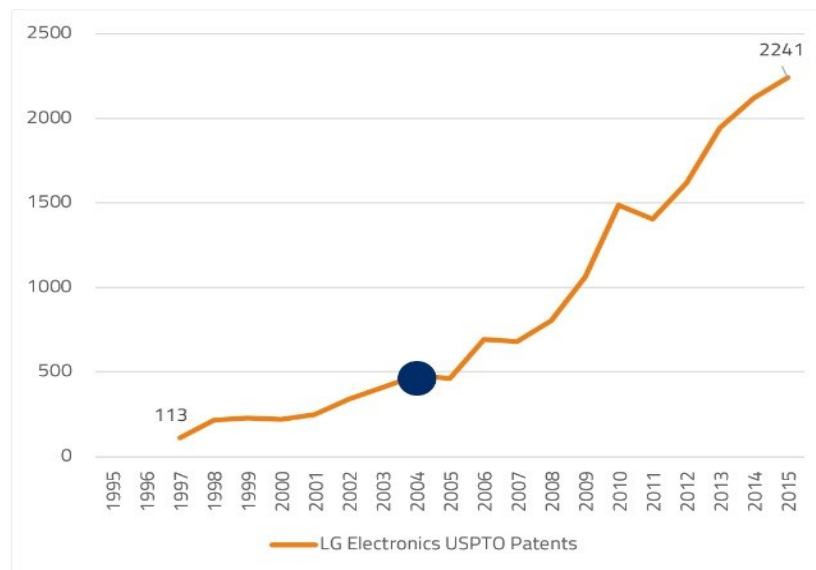
Figure 10. LG Electronics USPTO patents 1997-2015. Own study.

LG Electronics is a perfect example of the impact of modern TRIZ. Since TRIZ implementation commenced in 2004, the enterprise had recorded a most rapid increase in the number of patents granted by the USPTO – from 480 in 2004 to 2,241 in 2015. Today, patents obtained by LG Electronics account for 12% of all Korean patents granted by the United States Patent Office. The enterprise only required three years to commence such an intense growth.
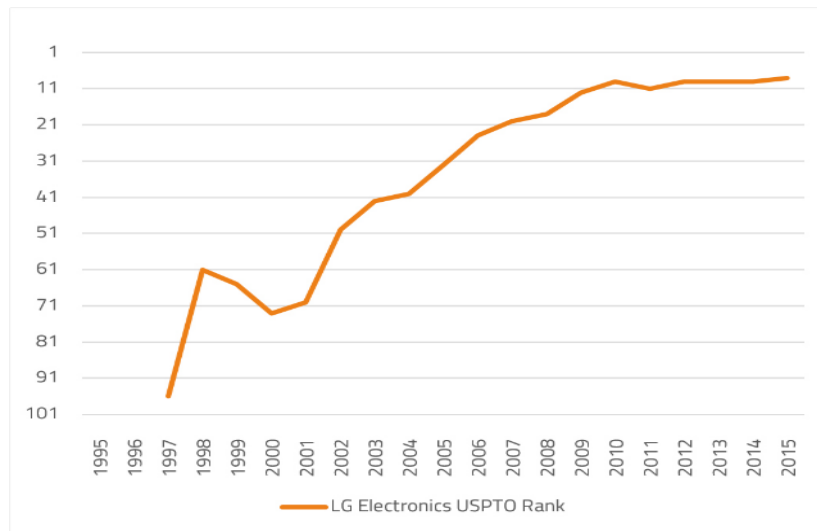
Figure 11. LG Electronics USPTO patent rank 1997-2015. Own study.

When LG Electronics commenced TRIZ methodology implementation in 2004, the USPTO ranked it the 40th in terms of the number of patents granted. A significant increase in their number over the period analysed led the enterprise to being ranked 9th in the statistics of the United States Patent Office in 2015.
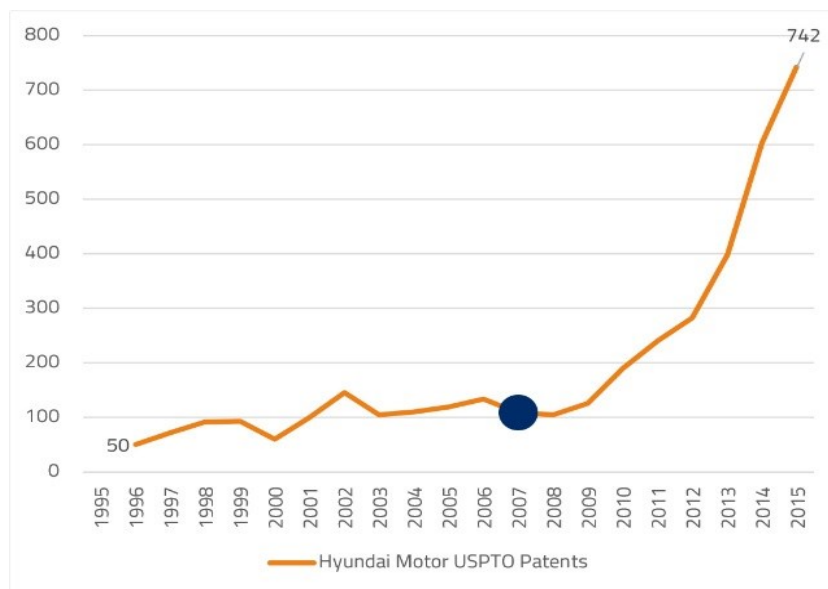
Figure 12. Hyundai Motor USPTO patents 1996-2015. Own study.

Another good example of the impact of TRIZ on corporate innovativeness is the situation of Hyundai Motor – the enterprise started with 109 patents at the time of implementation of the methodology in 2007, reaching 742 patents in 2015, which accounts for 4% of all Korean patents with the USPTO. The time required to observe the impact of TRIZ is even shorter – it took barely two years to observe a significant increase in the number of patents.
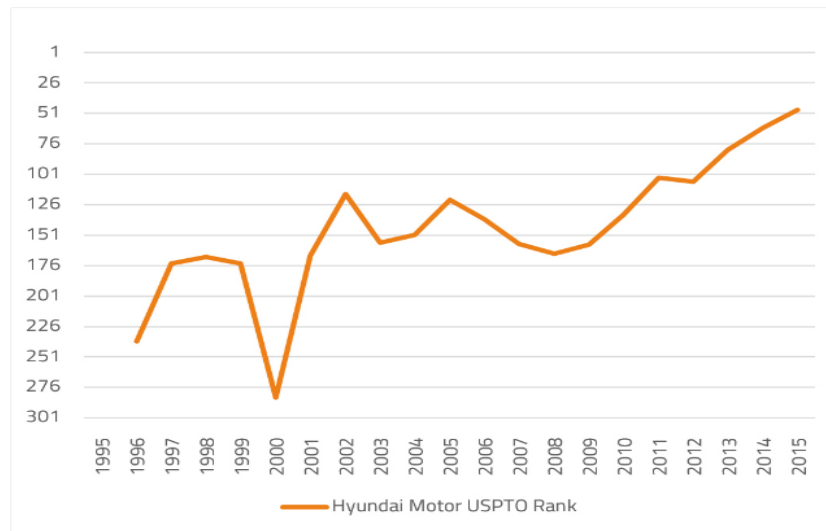
Figure 13. Hyundai Motor USPTO patent rank 1996-2015. Own study.

Hyundai Motor also followed the pattern of the previously analysed enterprises. At the time of TRIZ implementation in 2007, it was ranked 158th by the USPTO; after eight years, it was ranked 48th.

An analysis of the foregoing data shows that the correlation between South Korean enterprises that have implemented the TRIZ methodology and the growing number of their patents is relatively strong. TRIZ implementation appears to have a significant impact on their innovation rates. Interestingly, only three reported enterprises generate nearly half the patents obtained by South Korea from the USPTO. There is also one more dependency which it is worth highlighting. The fourth rapid increase in the number of patents appears to be linked to the growing number of TRIZ certifications. If one analysed the previous three rapid increases in the number of patents granted by the USPTO, they might observe they are closely linked to the dates of TRIZ implementation within individual Korean enterprises. This is a very interesting synergy.

The last factor worth analysing is how the growing number of patents may increase the value of individual brands. Eventually, innovations ought to provide their creators with profits. To that end, a decision was made to analyse *Brand Finance Global 500* reports covering the years 2007-2015 (http://brandfinance.com/knowledge-centre/reports, 2017). The following diagrams illustrate changes in the brand value of Samsung, LG and Hyundai in the period analysed.

Figure 14. Samsung Brand Value ($M) 2007-2015. Own study.

Figure 15. LG Brand Value ($M) 2007-2015. Own study.

Figure 16. Hyundai Brand Value ($M) 2007-2015. Own study.

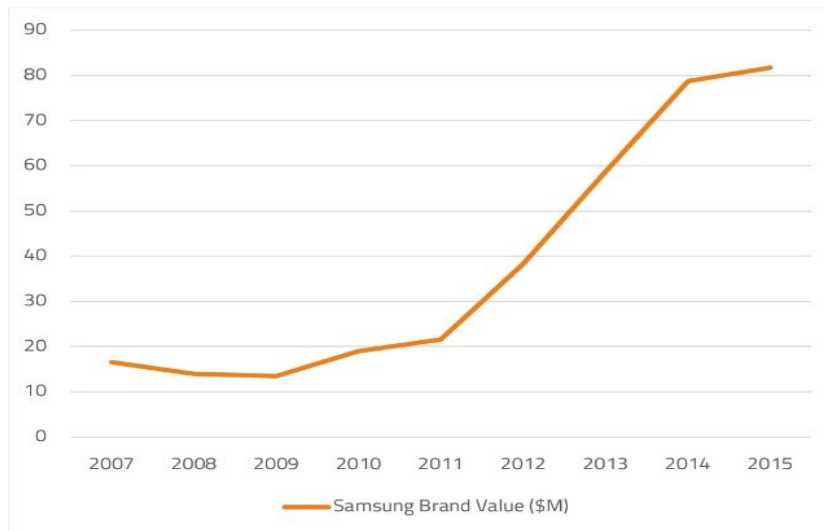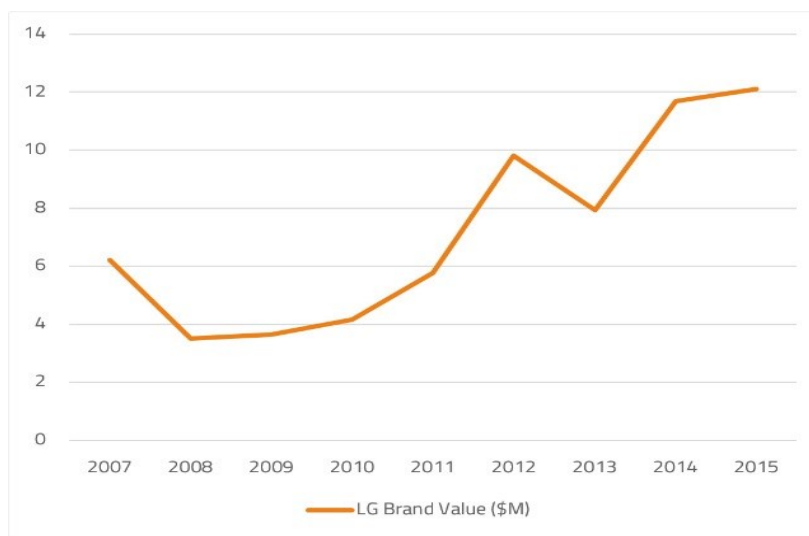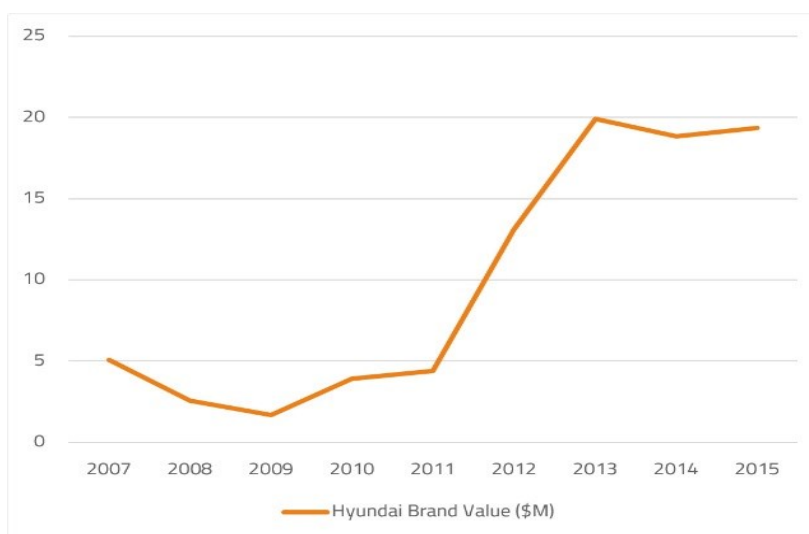As it may be observed, the growing number of patents in linked to the increase in the brand value, in the case of Samsung and Hyundai in particular. However, one ought to be aware of the fact that this is not the only factor affecting the value of individual enterprises, yet responsible management, capable of using innovation as a source of competitive advantage, can contribute to a significant increase in the value of the enterprise concerned. It is also worth mentioning that TRIZ does not oppose other methodologies, *Six Sigma* or *Kaizen* in particular. They complement one another perfectly, and their concurrent application may contribute to accomplishment of even better results.

This analysis was aimed at demonstrating the impact of the TRIZ methodology on the rate of innovation of selected enterprises. Of course, it ought to be noted that patents themselves do not ensure an increase in the value of the enterprise – it also needs market success. However, given possible identification of the potentially best market solution through the application of the TRIZ methodology, implementation thereof may provide the enterprise with a significant competitive advantage.

4. TRIZ in Poland

Thus, it is worth asking a question about TRIZ popularity in Poland. Despite the geographical proximity, the methodology developed by Altshuller has never been popular here. Although the first books authored by the creator of TRIZ were published back in the 1970s (Altshuller, 1975), not many people have ever been convinced of its efficiency. For a very long time, activities related to the methodology promotion and teaching could be referred to as an 'unstructured phase'. There were occasional mentions or articles in magazines, but a more serious interest did not arise until the 21st century. At that time, one could observe certain activities related to TRIZ educational activity, the first publications released in insignificant numbers of copies, or the very first projects and training sessions (Yatsunenko, Józwa, Karendał, Vintman, Przytuła, Boratyński, Boratyńska-Sala, and Stańczak, 2014, p. 269-272). This stage concluded with the granting of twenty 1st level certificates as well as by one of the TRIZ methodology implementation pioneers obtaining the 3rd level certificate in Poland back in 2013 (https://matriz.org/matriz-offices/council-on-expertise-and-methodology-cem/certification/lists-of-certified-triz-specialists, 2017). Aerfortis training company commencing its activities and conducting the first seminars on TRIZ at several enterprises and in the course of open meetings held back in 2014 was a harbinger of the increasing interest in the methodology. Those activities resulted in the formation of Novismo Group which significantly contributed to further growth of interest in the methodology in Poland.

Since 2015, activities related to the TRIZ methodology promotion and implementation have become much more intense. It was back then that the-then President of MA TRIZ, Professor Sergei Ikovenko, invited by the Patent Office of the Republic of Poland, came to Poland for the very first time to give a series of lectures on the methodology. It was that same year that, at the initiative of Novismo and Świętokrzyskie Centrum Innowacji i Transferu Technologii, the TRIZ Poland Foundation was established, and it held the first in Poland international event related to the TRIZ methodology – the TRIZ Kick-off Meeting 2015 – to which they had invited to further best TRIZ professionals in the world to give their lectures. This made it possible to introduce the methodology to a wider audience, dominated by entrepreneurs.

Along the growing interest and, most importantly, demand for TRIZ knowledge in Poland, Novismo Group, working in collaboration with Professor Ikovenko, commenced a series of MA TRIZ official certification training covering TRIZ 1st and 2nd level of knowledge. The training comprised both closed series of lectures and workshops designed for enterprises ordering them, and open seminars for the public. This resulted in a rapid growth of the number of professionals who could pride themselves on holding MA TRIZ official certificates. The diagram below illustrates the increase in the number of 1st, 2nd and 3rd level certifications in Poland in the years 2012-2017. It is worth noting that the number of certifications in 2017 (status as at November 2017) ought to increase even further.
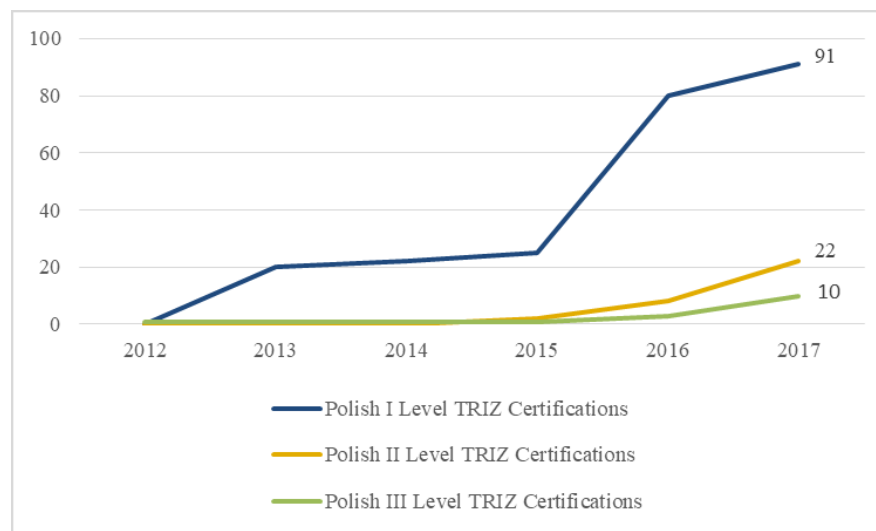
Figure 17. Polish I-III Level TRIZ certifications 2008-2017. Own study.

In barely two years, the number of Polish TRIZ professionals had increased nearly four times. When it comes to 2nd level professionals, the 2015-2017 statistics appear to be even more impressive: their number increased eleven times. Also, an increase in the number of 3rd level professionals is clearly visible; in 2017, there were as many as ten of them. What is interesting, the increase in the official number of TRIZ certifications in Poland, if slightly adjusted, is correlated to the dynamic growth of interested in the methodology all around the world. Although a lot more is required to reach the level of certification of South Korea,

recent years have certainly brought about a significant increase which makes it possible to assume mass interest in the TRIZ methodology is yet to arise.

The increase in the methodology also results in the holding of international events related to TRIZ. Save for the already mentioned 2015 TRIZ Kick-off Meeting, Poland hosted two most important conferences on the TRIZ Methodology. In 2016, Wroclaw hosted *TRIZ Future Conference 2016* – an international conference of TRIZ professionals, organised by the European TRIZ Association (ETRIA). A crowning achievement and recognition of the direction in which TRIZ had been developing in Poland was MA TRIZ granting the organisation of the most important methodology-related event – the TRIZ *fest* conference held in 2017 in Krakow. The event, held regularly throughout the world, attracted – just like every year – the most prominent TRIZ professionals from different continents to exchange their opinions and experiences related to practical TRIZ application. Organisation of the two largest events related to the European and the global TRIZ centres clearly shows that Poland is beginning to gain more and more respect and interest of the best TRIZ professionals in the world, which makes it possible to assume that with time Poland will join the group of countries applying TRIZ on a mass scale.

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THE COMPENSATION OF DISTRUPTIONS
IN THE DISTRIBUTION CENTRE

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Abstract: Disruptions occur in all distribution centres which work in nowadays market and participle in processes connected with goods flows. Due to this, the skill of detecting and dealing with disruptions is a very important issue. Disruptions could make impossible to correct actions of processes and have disaster financial or organisational effects. Distribution centres should look for and implement methods to effect disruption reducing, so they should improve their resistance. Article includes distribution centres description in the perspective of their meaning of disruptions compensation nodes in distribution network. Interpreting the concept of disruptions starts with the problem of compensation, resistance and risk and risk factors of disruptions. Main goal of article is a conceptualization of disruptions compensation model for regional distribution centre. Proposed disruptions identification and analysis procedure includes elements such as: diary method, disruption measurement card, FMEA, weighted average and Ishikawa Diagram. Procedure should be used for identification, measurement and propose preventive actions for all types of distribution centres.

Keywords: compensation, disruptions, distribution centre, resistance.

1. Introduction

Dealing with disruption is an extremely important thing for all organisations which are cooperating in supply chains and networks. In distribution networks, disruptions created in one of entity have a negative effect in all nodes cooperating in network, not even in organisation which has created it. One of methods to dealing with disruptions is a compensation of disruptions. It causes improve the level of resistance of logistics system.

Article focuses on showing the role of distribution centre in the compensation of disruption in the distribution network. Therefore, the interpretation and classification of disruption was showed. It also, by analysing an effects and reduction methods of disruptions, problems of improving resistance and compensation of disruption was considered. Article goal focuses on conceptualization of disruptions compensation model in the distribution

centre and elaboration of disruptions identification and analysis procedure in these types of entities. Therefore, the entity was described and next the results of researches and universal procedure was showed.

2. Distribution centre as a network node

Distribution centres are the one of middleman in goods distributions. According to acceptance of property rights classification (Bendkowski, Kramarz, and Kramarz, 2010, p. 149) distribution centres are characterized by 2 factors: they participate in goods flows and they don't have property rights of distributed goods. Distribution centres was defined as: separate entities, which are providing services for manufacturing and trading companies. All operations connected with goods distributions are mainly provided by this same company, which transfers goods to a lot of entities (Barcik, 2005, p. 160-161). Additionally, distribution centres are an element of logistics point infrastructure. Distribution centre includes: lands and buildings, equipment, management and working teams, hardware and software, procedures and operational methods (Baker, 2008, p. 15). It could specify 3 basic distribution centres types (table 1).

Table 1.
Types of distribution centres

Type	Characteristic
International Logistics Distribution Centres	Area: 100-150ha Range: 500-800km IT system: fully developed Logistics services: fully developed
Regional Logistics Distribution Centres	Area: 20-50ha Range: 50-80km IT system: average Logistics services: chosen services
Local Logistics Distribution Centres	Area: 2-10ha Range: 5-8km IT system: limited Logistics services: limited

Adapted from: "Logistyka dystrybucji" by R. Barcik. Copyright 2005 by ATH, p. 162.

Every type of distribution centre with tab 1 needs to fulfil varied functions. These functions are for example: goods flows managing according to customer needs, choosing the optimal carriers, cooperating the forwarding and logistics companies, using an infrastructure equipment, developing the integrated logistics systems, spreading the EDI and using advanced IT systems (Barcik, 2005, p. 161). Categories which are important for all centres, and which all centres should track and check all the time could divided into 8 groups (Robinson, 2017):

     – delivery on time – connected with right using of transportation equipment and correctly fulfilling distribution plans,

     – accurate order fulfilment – mainly connected with proper goods commission processes in the warehouses,

     – warehouse capacity monitoring – connected with avoiding of warehouse work overloads or too many supplies,

     – define a peak of warehouse capacity – it is a point where exceeding causes operational plans failure,

     – supply cycle times and internal processes connected with warehouse activities,

     – annually workers rotation – connected with the quantity of experienced employees,

     – goods reception time – connected with the time from arrival of cargo to locate cargo in particular places in warehouse,

     – percentage damaged goods – connected with cargo loses in both: warehousing and transportation processes.

Important role, in distribution centres, takes also factors connected with characteristics of its activities, surrounding and internal processes. It could be for example: characteristics of stocks, centres assortment, type of used loading units, economic conditions, quantity of goods receipt and release in distribution centre, geographical location, selling possibilities and customers or suppliers requirements (Śliwczyński, 2008, p. 132-133). Additionally, among these factors could be: customers and assortment analysis and definition, establish distribution centre capacity, potential goods and information flows analysis, choosing the location, consideration of using an outsourcing in some areas (Jezusek, and Widera, 2001, p. 16-17).

Good flows in distribution networks, where distribution centres are included, is possible by effective order fulfilment system. Customers order fulfilment includes 4 stages (Grabowska, 2008, p. 34). First stage consists of submitting an order by entity. Mainly it is done electronically, by using EDI. Second stage focuses on forming an information and sending it to the warehouse. In the warehouse takes place third and fourth stages. There are: preparing goods and sending them to the customer. This process is showed in the fig. 1.
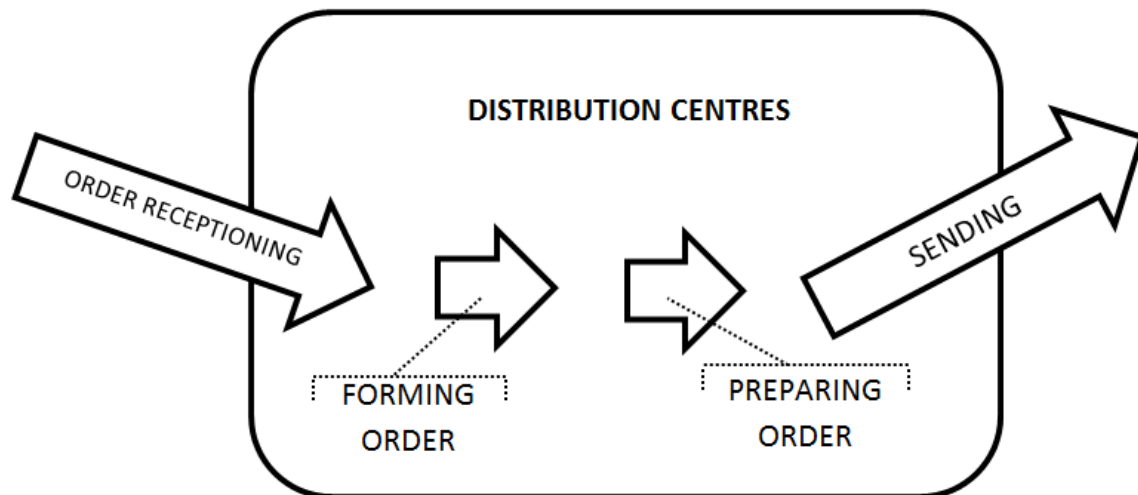
Figure 1. Order fulfilment process in distribution centre. Own elaboration based on: "Wpływ funkcjonowania centrum logistycznego na modernizację kanałów dystrybucji" by J. Grabowska. Copyright 2008 by Politechnika Śląska, p. 35.

Like is showed in fig. 1, all process stages occur chronologically and quality of one tasks has influence to quantity of final result. Efficiency of distribution centres could be measured by following indicators: financial (ex. repair costs), utilization (ex. percentage goods utilization), quality (percentage of good deliveries) or cycles time (Baker, 2007, p. 14). Besides mentioned indicators companies take a lot of different activities connected with satisfaction of final customer. It could be: internal warehouse transportation processes or placing orders. Characteristic features for this kind of objects are used tools (ex. EDI, MRP II, ERP, WMS), served customers area, infrastructure, average stocks indicator and efficiency of transportation and warehousing processes. Among elements which could improve centres activities there are for example: activities connected with VMI implement in centres, automatic IT technologies, reducing unnecessary warehousing movements, implement technologies aimed at warehousing processes optimization, for example: voice control, radio frequency (Harps, 2005). Therefore, one of the most important issue in distribution centres is their warehouse system, because majority of mentioned elements is concentrated within this area. Conditions, which have influence on warehouse system in distribution centres are showed in table 2.

Table 2.
Analysis of warehousing system conditions in distribution centres

Condition	Characteristics
Quantitative storage program	Includes following data: • type and form of stocks, • type of used load units, • max. warehouse capacity and level of safety stocks.
Occupied warehouse space	Includes: • working space of warehouse, • warehouse volume.

Operating cycle time	Includes: • time of operational and transportation cycles, • reloading and picking times.
Type and quantity of used technical staff	Measures based on daily effort of technical fixed assets.
Number and qualifications of employees	Includes employees which are working in the warehouse.
Investment costs	Includes circulation on warehouse fixed assets.
Operating costs	Includes wearing-out the materials, buildings and warehouse's devices.

Note. Own elaboration based on: "Planowanie logistyczne" by B. Śliwczyński. Copyright 2008 by Biblioteka Logistyka, p. 138-139.

Precise analysis of conditions from table 2 allows to fully use of distribution centre capabilities. Distribution centres allow to company better using transportation, warehouse, distribution processes (Barcik, 2005, p. 160). These benefits, in the literature, are extended by following factors (Bendkowski, and Kramarz, 2011, p. 275):

- centralization in the range of distribution control in one organizational structure,
- better matching transportation and warehouse systems to the infrastructure,
- using and perfecting IT systems,
- reaching benefits by using the scale economy.

Among main distribution centres strategies there are: postponement, delay the finish shape of products to reach the best personalization customer services, cross docking – stopping cargo only to reload to different kind of vehicle, without warehousing and using the third-part logistics to processes rationalization (Baker, 2008, p. 9-11). The most profitable situation is when the enterprise has a lot of dispersed customers. In this situation, when goods distribution is based on distribution centre, the same company does all processes. However, every process connected with goods flow is exposed to different deviations. That deviations are called disruptions, and enterprise, in this case distribution centre, should focuses on their compensation.

3. Compensation of disruptions

Disruptions, apart their kinds, are the results from different causes. There are 4 main sources of disruptions: processes, suppliers, customers and organization/control (Kramarz, 2013, p. 75). Additionally, the potential sources of processes disruptions are events connected with the groups of factors like:

- organizational, specify the development level of logistics systems, their efficiency and effectiveness of management methods,
- technical, which conditioning processes efficiency connected with technology of distribution, reliability of supply and logistics infrastructure,

–   economic, which have influence on physical flow, they slow down, stimulate or initiate the goods movement.

Additionally, that events could be also: operational causes connected with equipment or system errors, natural causes, for example: earthquakes, hurricanes, political instability and terrorism in particular markets which have influence on enterprise (Kleindorfer, and Germaine, 2005, p. 2-3).

Disruptions factors are every unexpected event which:

–   has crucial influence on system and causes state changing in this system (Kramarz, 2013, p. 71),

–   has destructive influence on system, which implies events far away from state of balance or activity goals (Oke, and Gopalakrishan, 2009, p. 168-174).

In the activity of companies there are a lot of this kind of events. There could be for example: order fulfilment time, lack of qualified employees, safety requirements level, limited communication, demand differentiation, insufficient distribution channels capacity, lack of system control, limited transportation and manufacturing capacity or insufficient quantity of suppliers (Kramarz, 2013, p. 83). A set of many factors which caused disruptions and occurred in logistics processes or systems could be called like disruptions strengthening zone. In different organizations these factors could occur in different probability and disruptions have different results. Therefore, disruptions analysis should be making in each of enterprises individually (Chopra, and Sodhi, 2004, p. 53-61) and every enterprise should prepare individually resistance attributes, too.

In the context of logistics, resistance has a lot of definitions, for example:

–   reaction capacity to unpredictable disruptions and reinstatement normally activities (Zaczyk, 2016, p. 584),

–   system return to balance state under the influence of disruptions (Kramarz, 2014, p. 45),

–   capacity to survive the exposure and keep the continuity of required functions in the acceptable effectiveness and quality level (Kramarz, 2015, p. 183),

–   organization's or system's attributes which secure enterprise for negative deviations caused by disruptions (Bukowski, 2016, p. 160).

System, which structure is resistant to disruptions is reliable and allows to quick reaction on disruptions. It could also reduce the disruptions in the way which doesn't cause negative effects in goods flows or financial and organizational loses. Among features, which could improve system's resistance is flexibility. Flexibility means system capacity to change adaptation. Beside this there are others variants like: suppliers or stocks excess. Using this methods to creating resistance could allow to fast network reconfiguration and disruptions impacts reduce. Additionally, activities which allow to improve resistance could be for example: network susceptibility audits in all stages from suppliers to final customers, making

rigours causes-effects analysis, creating strategically plans, making emergency plans (O'Reilly, 2014).

Different way to resistance rising stimulate could be wide range of using in all processes Internets, satellite networks, radio frequency technology and others, which allow to better information flows and smaller disruptions. However, some of disruptions factors, because of their nature, are tough to predict. Also, majority of disruptions is tough to predict and manage (Hendricks, and Singhal, 2005, p. 36). It could lead to the conclusion that it is impossible to reach the optimal system and processes resistance level, because always will appear new disruptions and system will have to prepare new solutions (Zaczyk, 2016, p. 590). Due to this, huge role in logistics processes has disruptions appearance risk and disruptions compensation. Compensation is one of the risk management strategy appealing to disruptions (Kramarz, 2015, p. 183).

Disruptions compensation is defined like a disruptions results reducing in the goods flows (Kramarz, 2013, p. 29). By compensation the results of disruptions are not spreading all over entities cooperating in the network. Material separation points are mainly responsible for compensation. On the other hand, disruptions occurrence risk includes: probability of disruptions occurrence and their influence (Konecka, 2015, p. 68).

During probability analysis, in the first stage, should be identified that disruption is caused by internal or external factors. Additionally, should be specified as caused by work errors or natural factors. Disruption influence is analysing in the 3 step scale from small to big. Considered factors are for example: enterprise size or disruption type. Disruption creating risk reaches when: supply network globalization, customer market increases and rise of nodes numbers in the network. Additionally, aspect, which could be consider in disruptions analysis, is their influence on enterprise capital risk. It could be measured by internal rate of enterprise capital return.

Among factor which could limit the risk of disruptions occurring there are (Konecka, 2015, p. 75):
- high requirements for supply punctuality indicators,
- choosing the nearest suppliers,
- simplification of orders planning and fulfilling processes,
- current information changing with suppliers and customers about stocks levels,
- sharing information about planning sales in the retails points,
- keeping high quantity of goods suppliers.

Additionally, activities which could reduce risk of disruptions occurring are: reducing bottlenecks and improve flexibility of enterprise (Kramarz, 2013, p. 36). Over the years the problem of disruptions reducing has developed from stock management to strategically level, which includes for example managing the supplier's bases or cooperation with them. Important area which has influence to company activity and which is extremely exposed to

disruptions is cooperation with suppliers. Failures of suppliers could lead to failures in enterprise activity (Wieteska, 2015, p. 147). One of conceptions to reducing risk of disruptions occurring is supplier's assignment to particular groups. Groups are specified in Kraljic's Matrix. In the next step adjustment activity to proper solution, it is showed in table 3.

Table 3.
Proposed activities to reaction against potential disruptions

Influence to financial result	Risk connected with supplies	Goods suppliers	Proposed activities
Big	Big	Strategic	Having an emergency supplier, detail plans in a lot of possibilities.
Big	Small	"Levers" type	Using multisourcing and sending orders to a lot of suppliers.
Small	Big	"Bottleneck" type	Keeping highly safety stocks level. Taking care of goods safety.
Small	Small	Standard	Using different sources of supply.

Note. Own elaboration based on: "Skuteczne reagowanie na zakłócenia – elastyczny łańcuch dostaw" by G. Wieteska. Copyright 2015, by Uniwersytet Ekonomiczny we Wrocławiu, p. 148.

Conception proposed in the table 3 allows to improve resistance of enterprise to disruptions, which are caused by failures in supplier's systems activities. In the case of key suppliers, this conception could be expensive, but the scale of potential disruptions results, makes them often profitable.

Additional elements of disruptions analysis should focus on the stages like:

− identification of appearing places of disruptions factors,

− identification of elements which are the source of disruptions,

− identification of disruptions,

− identification of loses and deviations caused by disruptions.

Causes-effects relations of deviations, which are caused by identified disruptions is showed in table 4.

Table 4.
Example causes, effects and deviations in goods flow

Causes	Effects	Deviations
• documentary failures, • incorrect IT system, • failures or lack of employees, • forklifts or vehicles breakdowns.	• maladjustment the system to reach the planning requests, • a long time of distribution and transportation processes realization.	• decreasing the level of logistics customer service, • incorrect stocks levels, • additional transportation costs.

Note. Own elaboration.

Causes-effects relation could be created by using for example Ishikawa Diagram. Occurred disruptions levelling could be made by analysis of their sources and deviations types. To identification and measure disruption there is a lot of methods. For example, suitable method to visualization of potential disruptions size could be FMEA and calculation

of RLF. RLF is a result from multiplication of: importance (Im), probability of occurrence (Pr) and detection (De), so:

$$RLF = Im \times Pr \times De \tag{1}$$

Appropriate methods and procedures selection allows to necessary activities implementation to reduce existing and protect from future disruptions.

4. Disruptions in distribution network – identification and role of chosen distribution centre

Entity which is considered in the article is a distribution centre which belongs to distribution centres network works in the Poland. This network supplies the network of retail points. In 2016 one centre flows daily about 4 000 000 pallets. Area of one centre is average about 400 000 m^2 and it could be classified like a regional distribution centre. Each of centres work in these same rules.

Due to the fact that distribution centre is distribution network coordinator, disruptions generated in centre have a crucial influence on every entity in mentioned network. Disruptions in goods flows mainly concern supply processes, cooperation with suppliers, warehouse management and distribution processes. In supply area the key disruptions are generated in the order fulfilment stage. To disruptions compensation enterprise is doing the varied policy of stocks management. For mainly goods the rotation of goods is equal 2,3 of day, while for quickly spoil goods is equal 1,1 of day. Relationships with supplier management is extremely important and require large financial contributions. Therefore, in the research centre this process is complex and precisely planned. Distribution centre uses suppliers measure cards, which consist of criteria such as quality, punctuality and reliability. Appropriate departments in company take part in creating relationship with suppliers. They state quantity of goods to order, take care of keeping correct stocks indicators in the warehouse. Suppliers provide goods to centre by using own transport fleet or by forwarders. They are obligated to provide goods in time planned by centre. It is allowed to provide them maximally half hour before or after planned period. In this stage the disruptions are generated, there are on the sides both suppliers and forwarder.

Procedure, which has developed and has used for make results in the identification and analysis of disruptions, consist of methods such as: process map, disruptions measurement card, Ishikawa Diagram and FMEA. Procedure is showed in the fig. 2.
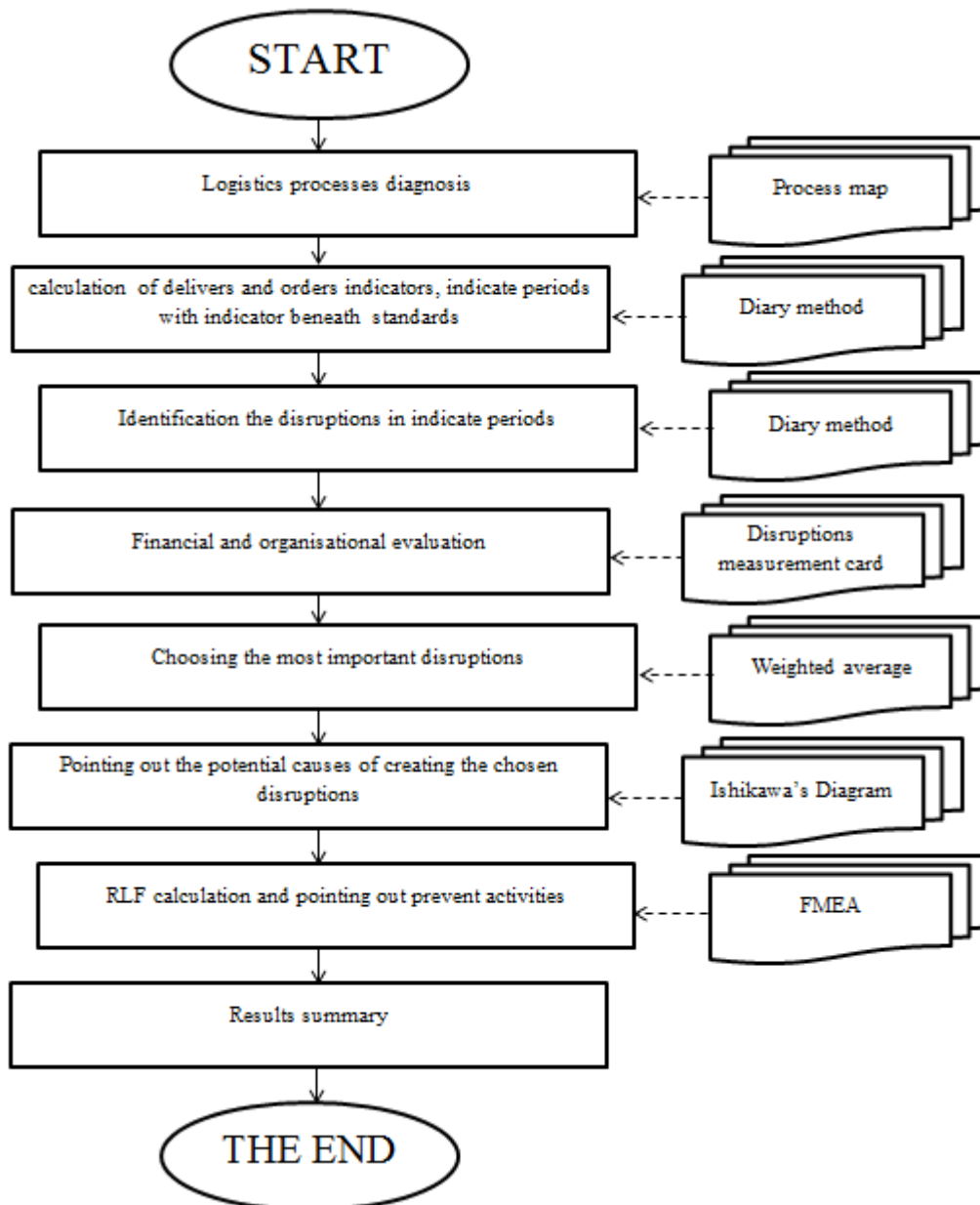
Figure 2. Identification and analysis procedure in distribution network based on distribution centre. Own elaboration.

Showed procedure starts with logistics processes diagnosis by using process map. After taking details about operation in processes, the next step focuses on calculation the deliveries and orders fulfilment indicators. It is need to show level of this indicators which are satisfied for enterprise. In the periods below this level the distortions are identified. Next, disruptions are analysed by disruptions measure card. Analysis contain of financial and organisational assessment in 5 grade scale. Disruptions are rated by using weighted average which consist of following weights: financial rate, organisational rate and number of occurrences. Mainly disruptions should be further evaluation, firstly by Ishikawa Diagram, which potential causes of disruptions are specified and next by using FMEA to show prevent activities.

5. Conceptualization of disruptions compensation in distribution network

Article includes the result of last stage of this procedure. According to FMEA for each of diagnosed disruptions in distribution centre it could be stated that:

- main areas of disruptions origins are activities connected with human's work, using methods, management and using machines and devices,
- disruptions are mainly generated inside the company, so they are result of incorrect run of processes in centre or outside of the company, connected with cooperation with suppliers and sometimes connected with natural causes,
- disruption could cause occurring one or several effects in one time. Effects have different intensity and importance to enterprise,
- for all disruptions could be using prevent actions, which enterprise could implement without breaking the continuity of processes,
- all prevent actions could decrease the level of RLF indicator.

Decreasing the level of RLF by using prevent actions to 3 most important disruptions is showed in table 5 and fig. 3.

Table 5.
Example causes, effects and deviations in goods flow

Disruption	Totally RLF of potential disruptions causes		Cumulative value	
	before	after	before	after
Lack of goods in warehouse	2239	880	58,38%	22,95%
Quality reject of delivery	820	263	21,38%	6,86%
Delay and reject delivery	776	247	20,23%	6,44%

Note. Own elaboration.

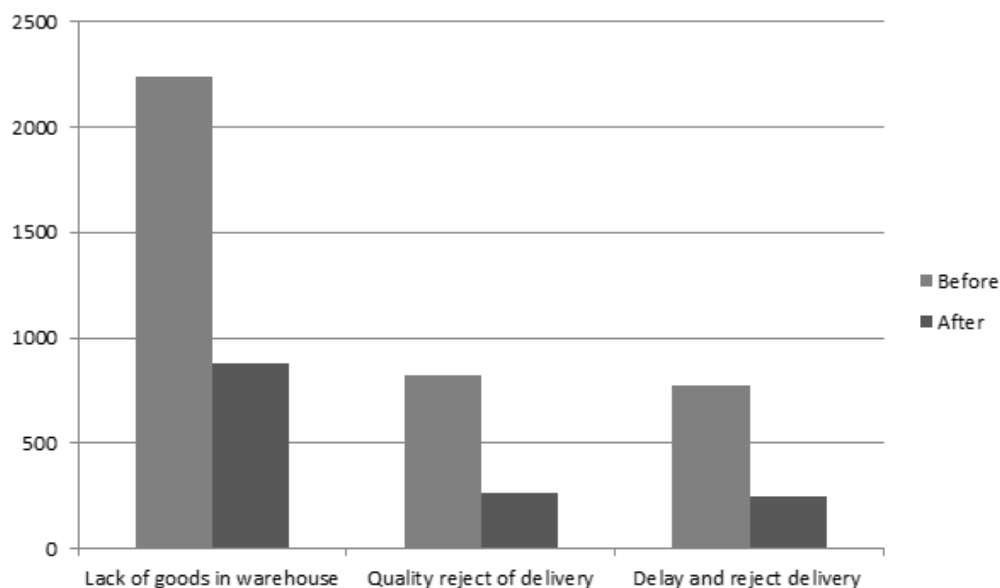**Figure 3.** Cumulative RLF quantity for disruptions before and after prevent actions implementation. Own elaboration.

Compensation of disruptions in distribution centre requires focusing on RLF improvement. Showed improvement could be reach by implement prevent actions which are specified in FMEA. This action mainly focuses on:

- – implementation of periodic trainings for warehouse workers,
- – enhancement the control of planned works and processes,
- – improvement of supplying procedures and increase the flexibility,
- – improvement of goods picking procedures,
- – taking care about quality of using devices, servicing and frequent exchanges or modernization,
- – modifications in IT system,
- – improvement of cooperation with suppliers,
- – control of supplier's actions, current reporting and taking the consequences,
- – increasing flexibility, mainly in reaction to unexpected changes in supplies schedule.

Compensation of disruptions strategy in distribution centre requires firstly: using proper stock management methods, which is varied to particular assortment groups (which mainly concern repetitive disruptions), secondly: taking long-term activities connected with information infrastructure and humans resources management (which allows to more effective reaction to disruptions and reduces the effects of hardly-predicable disruptions) and thirdly: increasing the organisation flexibility and perfecting processes and relations with suppliers (to reduce disruptions). First and second variants are the elements of disruptions compensation strategy, while third applies to disruptions minimization strategy. By the fact that distribution centre is a network coordinator of goods flows it needs to take decisions in extraordinary situations, for example when unexpected disruptions appear and delivery have huge priority for customer. This kind of decisions are extraordinary transport which requires creating the network relationships with transportation companies.

6. Summary

Creating the appropriate methods of disruptions compensation for goods flows coordinate enterprise in distribution network is extremely important issue. Properly disruptions reducing could have positive results for both the enterprise which disruptions are concerned and other entities which are taking part in this same distribution network.

The possibility of prevent actions implementations was observed in examined enterprise. These actions could lead to disruptions and their effects reducing. Showing the variants of disruptions compensations required creating the disruptions identification and analysis procedure, too. Disruptions compensation methods could be customized to disruptions

frequency (predictability) and to effects which disruptions bring to distribution centre and other entities working in the network. Procedure is universally and flexible tool which could be implement in all entities connected with goods and information flows where the disruptions could appear.

It is needed to remember that disruptions are an integral part of company function. Disruptions are integrated element of organisations functioning. They are changing all the time, so the most important thing, if enterprise wants to ensure functioning continuity and competitive advantage, is the constantly creation of distribution network resistance. Creating resistance consist of periodic analysis of potential disruptions to compensate them.

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IMPACT OF REFUGEE AND MIGRATION CRISIS ON GREEK TOURISM DESTINATIONS

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Abstract: The refugee and migrants movement is a historical phenomenon, driven by global forces and having effects on politics, economy and community of the hosting countries. Especially, the refugee and migrant stream of recent years – 2015 and 2016, has a decisive impact on the demand of touristic services on the Greek islands in northern Aegean Sea. The aim of the study is to examine and to compare the expected and the real impact of the current migrant and refugee crisis on the tourism, social and economic sphere on the islands according to the interviewed hoteliers on islands Lesvos and Chios. Crucial to maintaining the good image of these tourism destinations, is the good coordination between the local communities, local authorities and those at national, regional and international level on marketing, economic and regional policy.

Keywords: refugee crisis, migration crisis, Greek islands, impacts on tourism.

1. Introduction

There are durable actual international trends affecting migration in the modern world, like growth of illegal migration, growth of forced migration, increasing demographic significance of international migration and globalization of world migration processes (Tsoneva, p. 132). These trends seem to have impact to the islands Lesvos and Chios, as tourism destinations. The examine islands situated in North Aegean Sea and due to their favorable location near the coast of Turkey became a bridge to Western Europe for large numbers of migrants and refugees, coming from Syria, Afghanistan, Bangladesh, Eritrea, Sierra Leone etc. Their presences seem to change the touristic image of the destinations. According to the results of the questionnaire which examines the impact of migrant and refugee crisis on Greek tourism industry from January-February 2016, with these from September-October among hoteliers in the summer resorts of the two island, in some situations there is a significant difference between the expected and the real impact of the current migrant and refugee crisis on the tourism, social and economic sphere on the islands.

2. Literature review

Migration is for various reasons, abandoning of native land. The reasons that lead to the phenomenon of migration vary and depend on the conditions prevailing in the particular period in the areas of residence. In the scientific literature migration takes the separation of internal and external, voluntary and compulsory, primary and secondary, conservative and radical, complete and partial.

According to *J. Isaac* (1949, p. 379) possible reasons that make migrants to move, are political, social, economic and demographic changes in the country of origin. For the ethnologist *Robert Gordon Latham* (Encyclopedia Papyrus Larousse Britannica, 1990) primary migration covers the movement of such population groups, which aim absorption of uninhabited and unused areas as secondary migration means contact to him that migrates with the relevant indigenous population. Secondary migration movements are of slower rate, due to the response of another national group against new arrivals. Migration flows of this kind, most times are accompanied by violence, which leads to either merge the old with the new population, or disappearance of one of the two populations. *R. Mayo-Smith* splits migration to internal and external. The first is defined as movement within the one or the other country, and the second covers the movement of residents of a country within its borders. According to *J. Isaac* the reason for migration, both voluntary and compulsory, is the experience of those who emigrate to dispose of various factors that oppress them life and personal and therefore these two categories represent two different sides of the same phenomenon. *W. Petersen* distinguishes two types of migration, conservative and radical according to the consequences that this migration is causing to the social and financial situation of receiving countries. International law distinguishes migrants from refugees, people fleeing to find refuge from war, natural disaster, or political persecution (Goldstein, and Pevehouse, p. 434). Migration has a dynamic quality (Migration, Sociological studies 1969) and covers the cases where the decision to migrate is taken freely by the individual concerned, because of personal convenience and without intervention by an external compelling factor.

Dimitrov P. (2007, p. 2, 19) talks about that in unfavorable tourism conjuncture the supply structure is deteriorating, the manufacturing base cannot access the optimum, as well as the labor resources, the competition is increasing and the final financial results are worsen. In terms of demand, the picture of tourism conjuncture has strong relationship with the demographic trends and sociocultural changes. He also notes that in view of the fact that tourism is not a vital service, tourist behavior is highly vulnerable to psychological and social influences, personal sensitivities and short-term reactions. If the image of a destination just in one link of the chain is bad then the all perception suffers.

Another researcher, Hein de Haas (2008, p. 3) notes among the main reasons why it is hard to make general explanations about the causes and the consequences of migration are the

diversity and complexity of the phenomenon, as well as the difficulty of separating migration from other socio-economic and political processes. Describing the historical-structural theory he notes that "historical-structuralists postulate that economic and political power is unequally distributed among developed and underdeveloped countries, that people have unequal access to resources, and that capitalist expansion has the tendency to reinforce these inequalities. Instead of modernizing and gradually progressing towards economic development, underdeveloped countries are trapped by their disadvantaged position within the global geopolitical structure".

According to Goldstein and Pevehouse (2011, p. 436) "refugees are both a result of international conflict and a source of conflict". Ekberg (1999, p. 412) notes that "immigration may affect the income conditions of the native population in many ways". There may be effects on the markets, on employment opportunities for natives and on economic growth.

The World Bank (2013) has studied the impact of the Syrian conflict in the economic and social life in Lebanon and had found that the conflict and the open border policy are pronounced in the services trade sector and in particular to the large tourism sector – "with the number of international visitors having steadily declined since 2010".

Threats and uncertainty have always been a part of human existence as Ostrowska (2014, p.75, 78) notes. Nowadays, in a global economy integrated by modern infrastructure and telecommunications, by high and good quality of education when communication, work procedures and quality of life seems to be better than a century ago, motivation is still according to Lebeau (Dougherty, and Pfaltzgraff, 2004, p. 335) a key moment in the crisis behavior. Leaders are convinced that they need to act in so far as responding to interests and actions of other actors who are obstacle to the success of their policy. As a result, the leaders may be neglected or omitted information, which contains the reverse signs relative to the direction of action they have undertaken, in order to support their predetermined goals. Fair or not it happens, and today refugee or immigrants live in "camps" in the examined regions, that have become long-term neighborhoods, as the one in Jordan, Lebanon and the Palestinian territories of Gaza and the West Bank (Goldstein, and Pevehouse, 2011, p. 436).

3. Methodological framework of the survey

In this paper the researcher works on a case study, concern the Greek islands Chios and Lesvos and the impact of the refugee and migration crisis on these tourism destinations. Like a result of these observations the researcher tries to make some generalizations on the topic. This is inductive approach. At the same time the research is based in some theories (deductive approach). Finally the methodology used is a combination of inductive and deductive approach. The instrument of the inductive approach is the questionnaire. The research was conducted by the author from September to October 2016. The questionnaire was distributed to hoteliers in

the summer resorts of the two islands – on island Lesvos and island Chios, which are two of the islands through which pass a great number of refugees and immigrants in order to continue their road to the other countries of Europe. According to data taken from the Hellenic Chamber of Hotels the total number of registered hotels in the examined islands is approximately 178. The sample size of the research in this period of time is 168 hotels, an appropriate size for this research, taking into account the table for determining the minimum returned sample size for given population size (Bartlett, Kotrlik, and Higgins, 2001).

4. Analysis and evaluation of results

To the question "In your opinion which will be the impact of refugee and migrants crisis on the local economy of the Greek islands?" the majority of the interviewed hoteliers on island Lesvos 81.1% and island Chios 83.58% share the pessimistic opinion that the income of enterprises as a whole in the business sector will decrease. As about the income of tourism enterprises specifically, one 10.89% of the hoteliers on island Lesvos and one 11.94% of them on island Chios think that they will decrease. Interesting are the results of these almost 12% that answer "Only the impact of tourism enterprises will increase" or "The income of enterprises in general will increase", noting that they will achieve this with the stays and shopping of the refugees and immigrants themselves, as well as with the NGO's and reporters and photographers from all over the world that have interest, doing their work to visit and stay on the islands. When the hoteliers were asked in September-October which is their opinion about the real situation on the islands the results on island Lesvos were similar with the expectations they had in January-February, but for island Chios there are differences in all aspects – with most interesting result the one that shows that 43% less respondents than in January-February think that the income of enterprises in general has decreased.

Table 1.
Impact of refugee and migrant crisis on the local economy of the Greek islands

№	Answers	Island Lesvos		Island Chios	
		Jan.-Febr. 2016	Sept.-Oct. 2016	Jan.-Febr. 2016	Sept.-Oct. 2016
1.	Increase of tourism enterprises income	4.95%	2.97%	2.98%	8.95%
2.	Increase of income of enterprises in general	2.97%	5.94%	1.49%	17.91%
3.	Decrease of tourism enterprises income	10.89%	2.97%	11.94%	32.83%
4.	Decrease of income of enterprises in general	81.1%	84.15%	83.58%	40.29%
5.	Other	0%	3.9%	0%	0%

Source: Krasteva, and Pantelis, 2016.

As regards the impact of refugee and migrants crisis on the local social-demographic physiognomy of the Greek islands there are serious differences from what the hoteliers believed that will happen and what they think that really happened. The most contrasting results concern

the answer "The number of the permanent population in the settlement of the island remains stable" with some 24.78% of the hoteliers of island Lesvos and some 25.3% of them of island Chios given this answer in January-February 2016 and respectively some 66.33% and 40.29% in September-October 2016.

Table 2.
Impact of refugee and migrant crisis on the social-demographic physiognomy of the Greek islands

№	Answers	Island Lesvos		Island Chios	
		Jan.-Febr. 2016	Sept.-Oct. 2016	Jan.-Febr. 2016	Sept.-Oct. 2016
1.	Increase of permanent population in the settlements of the island	22.78%	25.74%	19.41%	29.85%
2.	The number of the permanent population in the settlement of the island remains stable	24.78%	66.33%	25.3%	40.29%
3.	Decrease of the permanent population in the settlements of the island	19.8%	0%	22.3%	0%
4.	Young people stay and work in their hometown	15.8%	7.92%	17.9%	29.85%
5.	None of the above	16.8%	0%	14.9%	0%

Source: Krasteva, and Pantelis, 2016.

The fear of decreasing of the permanent population in the settlements of the islands, expressed from 19.8% of the respondents on island Lesvos and 22.3 % on island Chios was ungrounded. In the same levels (but a little bit higher for island Chios) with the one from January-February are the percentages for September-October about increasing the permanent population in the two islands, and about the staying and working of young people in their hometown.

The analysis about the impact of refugee and migrant crisis on the regional policy and the natural environment of the examined Greek islands for the period January-February 2016, shows that hoteliers from both island Lesvos and island Chios think that there will be negative effects on the natural environment and the infrastructure of the islands, as a result of the great number of arrivals and long stay in terms of time of migrants and refugees – some 83.1% from the respondents on island Lesvos and some 82% of them on island Chios. When the same questions were asked in September-October 2016 the results were significant lower 50.5% on island Lesvos and 20.91% on island Chios. The expectations about sponsoring infrastructure projects both from the state on the one hand and from the local municipalities on the other, remains low to insignificant – from 1,98% the lowest to 4,95% the highest in January – February 2016 and from 11.88% to 14.91% in September-October 2016. Almost 10% is the percentage of hoteliers that in the winter months believe that the situation will remain unchangeable and there will be no consequences on infrastructure and the natural environment of the areas as a result of the presence of refugees and immigrants, but in autumn a greater number of them, some 24.75% on Lesvos and 55.23 on Chios share this opinion.

Table 3.

Impact of refugee and migrant crisis on the regional policy and the natural environment of the Greek islands

№	Answers	Island Lesvos		Island Chios	
		Jan.-Febr. 2016	Sept.-Oct. 2016	Jan.-Febr. 2016	Sept.-Oct. 2016
1.	More infrastructure projects sponsored by the State	4.95%	11.88%	4.47%	14.91%
2.	More infrastructure projects sponsored by the local municipalities	1.98%	12.87%	2.98%	8.95%
3.	Negative effects on the natural environment and the infrastructure of the island	83.1%	50.5%	82%	20.91%
4.	The situation remains as it was	9.9%	24.75%	10.44%	55.23%

Source: Krasteva, and Pantelis, 2016.

To the question about the impact of refugee and migrants crisis on tourism sector of the Greek islands the interviewed in January-February hoteliers answer that they expect for the summer months of 2016 to have lower overnight stays (33.66 %) and lower visits (26.73%) than the summer of 2015. Interesting are the results from these almost 40% that answer "Another impact" and fill in the questionnaire that they will achieve completeness in the hotel with the stays of the refugees and immigrants themselves, as well as with the NGO's that have interest, doing their volunteer work to visit and stay on the island. But, when the hoteliers were asked in September-October about the real situation for the summer months of 2016 still a great number of them – some 55.44% on island Lesvos and 73.37% on island Chios declare that the overnight stays and visits are lower than the one in the previous summer. As during the winter months the respondents didn't choose the answers "The number of overnight stays will increase", "The number of overnight stays will remain the same as last year", "The number of visits will increase", some months later, in September-October 2016 about 27.69% in island Lesvos declare that overnight stays and visits were higher during the summer of 2016 in comparison with the summer of 2015, and almost the same percent in island Chios says that the overnight stays remain the same as last year, but still no one thinks that the overnight stays and visits were higher during the summer of 2016 in comparison with the previous summer.

Table 4.

Impact of refugee and migrant crisis on tourism sector of the Greek islands

№	Answers	% of hoteliers on Island Lesvos		% of Hoteliers on Island Chios	
		Jan.-Febr. 2016	Sept.-Oct. 2016	Jan.-Febr. 2016	Sept.-Oct. 2016
1.	The number of overnight stays is lower than these of last year	33.66%	26.73%	44.78%	33.11%
2.	The number of visits is lower than these of last year	26.73%	28.71%	17.91%	40.26%
3.	The number of overnight stays is higher than these of last year	0%	27.72%	0%	0%
4.	The number of overnight stays remains the same as last year	0%	13.87%	0%	26.63%

5.	The number of visits is higher than these of last year	0%	2.97%	0%	0%
6.	Another	37.31%	0%	37.31%	0%

Source: Krasteva, and Pantelis, 2016.

According to the answers given in the period January-February divided seems to be the opinion of the hoteliers on islands Lesvos and Chios, about the expected impact of refugee and migrant crisis on the island as a tourism destination, as some 48.51% of the hoteliers from island Lesvos and some 49.25% of them on island Chios think of positive impact and specially "That the island will become a world famous destination" and some 49.50% of the hoteliers from island Lesvos and some 46.26% of them on island Chios gave answers that show a pessimistic point of view – "That the island will be defamed".

In the same question, but some months later the results are totally different on island Chios, as now the majority of the share the opinion that the refugee and migrant crisis will lead to the defamation of the island. On island Lesvos some 44.55% of the respondents are still pessimists about the development of the island as a tourism destination and the same percentage of them think that the situation remains as it was before the refugee and migration crisis.

Table 5.
Impact of refugee and migrant crisis on island as a tourism destination

№	Answers	Island Lesvos		Island Chios	
		Jan.-Febr. 2016	Sept.-Oct. 2016	Jan.-Febr. 2016	Sept.-Oct. 2016
1.	The island become a world famous destination	48.51%	10.90%	49.25%	11.95%
2.	Defamation of island	49.50%	44.55%	46.26%	83.58%
3.	Nothing of above	1.98%	44.55%	4.47%	4.47%

Source: Krasteva, and Pantelis, 2016.

5. Conclusions and Recommendations

Finally, the survey results indicate that:
1. The refugee and migrant crisis contribute for an unfavorable tourism conjuncture on the Greek islands of the north Aegean Sea.
2. In some aspects of the study, like the demographic physiognomy and the impact on tourism there is a significant difference between the expectations of the hoteliers on both Lesvos and Chios about the impact of the refugee and migrant crisis on the islands as tourism destinations and the estimation they made about the real situation there.
3. Concerning other aspects of the study, like the impact on economy and regional policy and the impact on natural environment, that has the refugee and migrants crisis, on the one island there are differences between the expectations expressed in January-February

and the real situation about the summer months, expressed in September-October and in the other there are more similarities and the opposite for the different questions.

Of course these results couldn't be generalized as a theory yet, because of the local character of the research and the short term of study. Through the centuries states have been increasingly working together to regulate population movements and provide refugee relief through regional and global negotiations and international coordination (Venturas, p. 2). These movements are a global historical phenomenon, but for the Greek islands they are a new challenge in a difficult period of financial crisis, that needs a good and adequate approach to bring positive effects on the tourism industry, the local economy and the local community without violating human rights and freedoms. Crucial to maintaining the good image and identifying these islands known as tourist destinations, which are offering high quality and professionalism of tourism servises is the good coordination between the local communities, local authorities and those at regional, national and international level on marketing, economic environmental and tourism policy. They should establish the balance needed in order to contribute to positive results in the touristic sector of the region.

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CREATIVITY AS A FACTOR SUPPORTING DEVELOPMENT OF SMART SPECIALISATION AT THE STAGE OF UNIVERSITY EDUCATION

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Abstract: The article deals with significance of creativity considered as a significant mechanism supporting development of smart specialisations. Creativity is most frequently analysed in the context of innovation and perceived as a more effective way of implementing innovative processes. This increases the need for knowledge and creative thinking skills. In that respect, universities ought to play a key role. The article highlights interrelations between development of smart specialisations and the need to integrate creativity into university curricula.

Keywords: creativity, smart specialisations, universities.

1. Introduction

Development of smart specialisations depends on various factors and mechanisms, in particular those affecting innovative activity and development of employees' creative attitudes. Therefore, this article focuses on the construct of creativity treated as one of key mechanisms of smart specialisation development.

In accordance with modern trends related to intelligent development, the economy, various organisations, institutions, and businesses need educated professionals with creative thinking and problem solving knowledge and skills. The knowledge and the skills facilitate the process of selection and development of smart specialisations. In this regard, universities play an important role.

The role of the university education sector is primarily to develop and social human capital, knowledge infrastructure, knowledge and skills in accordance with needs, and commercialisation of research results (Guide…, 2012). To optimally use the potential of a specific region, the university education system ought to take into consideration the market demand for specialised personnel within the framework of identified smart specialisations. This is an important element of building and acquiring human capital for the innovation

ecosystem that generates new ideas for innovative solutions which bring benefits to the European economy and society.

The aim of the article is to discuss the nature and importance of creativity to development of smart specialisations at the stage of university education. The article also presents theoretical assumptions of the smart specialisation concept and the role of universities in their development. Moreover, the article presents selected educational programmes and projects regarding creativity, implemented on the national and the regional level, based on an exemplary university.

2. The essence of smart specialisations

The concept of smart specialisation is oriented at achieving and maintaining competitive advantage of EU countries and regions in the global economy owing to the concentration of knowledge and focusing it on a limited number of priority actions (Guide…, 2012). According to the concept, regions and countries that combine innovation with their unique strengths and capabilities of the economy based on the infrastructure and knowledge base as well as the industry structure have a greater chance of success (Guide…, 2012). The concept of *smart specialisations* is the outcome of the work of the *K4G: Knowledge for Growth* Expert Group appointed in 2005. Assumptions regarding the regional specialisation idea, co-authored by, inter alia, D.P. Foray (David, Foray, and Hall, 2007), were presented in 2008 in the working documents of the Group as well as in a report containing recommendations regarding the functioning of the European Research Area (The role…, 2009). Creators of smart specialisation name four key principles on which the concept is based (quadruple 'C'): tough choices and critical mass, competitive advantage, connectivity and clusters, and collaborative leadership (Foray, Goddard, and Beldarrain, 2012). The concept was primarily popularised with the Communication from the European Commission titled Europe 2020: A strategy for smart, sustainable and inclusive growth (KOM 2010 (2020), 2010). Smart specialisation remains closely related to one of the three main priorities of the Europe 2020 – Smart development based on knowledge and innovation strategy. It is also a pillar of one of the seven flagship initiatives known under the name of 'Innovation Union', falling within the framework of the Europe 2020 strategy.

The concept of smart specialisation is an important implementation element of the innovation policy. In practical terms, of crucial importance was the Guide to Research and Innovation Strategies for Smart Specialisations (RIS3), published in May 2012 and developed with the use of a smart specialisation platform. The Guide contained detailed instructions for regions and Member States with respect to methods of development and implementation of research and innovation strategies for smart specialisations. Development of the 'Research and

Innovation Strategies for Smart Specialisations (RIS 3) is designed to allow the use of EU structural funds more efficiently and to increase the synergy between different EU, national and regional policies as well as public and private (http://ec.europa.eu/…) investments. RIS 3 is a key part of the proposed reform of the EU cohesion policy that supports thematic concentration and strengthens strategic programming and effectiveness (http://ec.europa.eu/…). These strategies are supposed to encourage all partners to integrate within a common vision and to develop a creative social capital within the community.

Smart specialisation means identification of unique characteristics and assets of each country and region, highlighting of the competitive advantage of each region, and concentrating regional partners and resources around an accomplishment-oriented vision of their future (http://ec.europa.eu/…). It also means strengthening of regional innovation systems, maximising of knowledge transfers, and dissemination of innovation benefits throughout the entire regional economy (http://ec.europa.eu/…).

The very concept of smart specialisation is based on various underlying theories (see Table 1).

Table 1.
Theories to which the concept of smart specialisation refers

Theories	Theory description
Neo-factor theories	Apart from work and capital, the theories classify human capital and natural resources of the country as production factors.
Nanotechnological theories	They stress the importance of technological developments and innovation that affect intensification of exports from a specific national economy.
Technological gap theory	The theory lists technologically innovative countries that are capable of creating new products and solutions, and imitating countries that build their competitive position based on less expensive production factors.
Staple theory by H. Innes	According to Innes, regional development is driven by the creation of gradual specialisation in the production of products that are considered to be the strongest in external markets in terms of competitiveness. Specialisation of production results in a reduction of transaction costs, primarily as a result of improved production processes and resulting product quality.
Flexible Production theory by Piore and Sabel	The concept assumes that development based on small and medium-sized enterprises, freely changing the nature and direction of production to adjust to prevailing market conditions, technological developments and consumer requirements makes it possible to define specialisation that may contribute to identification of a market niche in the global market.
Absolute Advantage theory by A. Smith	According to the absolute advantage theory, selection of specialisation on the national level is determined by absolute differences in the costs of production of a specific product.
Heckscher–Ohlin theorem by E. Hechscher and B. Ohlin	According to the theory, selection of specialisation is determined by the difference in the costs and prices of production factors generation that are a function of rarity or abundance of those factors in individual countries.
Industrial Districts concept by A. Marshall	An industrial district is defined as a spatially separate area in which specialised industrial plants are located. Industrial districts form stable local communities with a well-developed service infrastructure supporting specialised regional production.

Competitive Advantage theory by M.E. Porter	Porter's concept, having elements that are common with Marshall's industrial district theory, emphasises the importance of geographical proximity (agglomeration, spatial concentration) and of establishment of industry clusters within which there arise cooperative interrelations. The concept is based on the location paradox, meaning that in the contemporary economy the production process is located locally, although goods produced are sold globally.
Growth Poles concept by F. Perroux	According to the concept, the growth poles identified have the strongest market position and are characterised by dynamic growth of economic activites as well as strong cooperative interdependencies. Not only do they drive economic growth but also constitute a potential capable of subordinating and making dependent business entities which are weaker than them. The Growth Poles theory is also related to the most developed regions.

Note. Original study based on: "Strategia inteligentnej specjalizacji w kontekście wybranych regionów Polski" by E. Romanowska, A. Firgolska, and J. Hrudeń. Copyright 2014, p. 55-78.

Consequently, the concept of smart specialisation is not completely new. It is but an improvement to the existing structural fund planning methodology. It is based on regional experiences in the area of supporting innovative strategies and on the leading economic thought on the part of leading international institutions, for instance the World Bank, or the OECD (http://ec.europa.eu/…).

3. Creativity as a mechanism supporting intelligent specialisations

A key premise of the concept of smart specialisation is the application of the entrepreneurial exploration of new domains of specialization (Guide…, 2012) and learning processes. Thus, there is a need to identify factors required to implement the process and to create an effective innovation system that fosters diffusion of various types of innovation. Due to its importance within innovative processes, creativity plays an important role in that respect. This has been noted by, inter alia, Sexton and Browman-Upton (Sexton, and Browman-Upton, 1991). Creativity turns out to be a critical competence in the functioning and entrepreneurial development of modern organisations as well as in the implementation of innovative undertakings and projects. Consequently, creativity is becoming more and more crucial as the right brain material that contributes to the generation of the highest level of growth (Knop, Szczepaniak, and Olko, 2014, p. 246). Wu and others emphasise particular importance of creativity in the implementation of new undertakings which are the basis for generating new ideas that initiate the process of entrepreneurial (Wu, McMullen, Neubert, and Yi, 2008) and innovative activity.

To a large extent, smart specialisation development possibilities result from the use of employees' research and development capacity. This, in turn, depends on employees' creativity and innovativeness. As J. Brzóska emphasises, the level of growth of organisation's innovation depends on pro-innovative activity, formation of support for employees' creative

attitudes, their competences and ability to cooperate (Brzóska, 2014, p. 38-48). It is considered that creativity is a mixture of, on the one hand, interaction of intellectual competences, creative talents and personal characteristics, and, on the other hand, a broadly interpreted socio-cultural and economic environment, and the environment within the organisation – in the sense of organisational climate (Bednorz, 2014, p. 13). Creative attitude helps solve organisational problems, motivates and encourages employees to implement innovative solutions, and fosters better teamwork (Machnik-Słomka, 2015, p. 216-228).

Creativity is an important development mechanism of organisations and undertakings, in particular those of innovative nature, as it establishes a new outlook on the development of modern economy which, as it is more and more frequently emphasised, is subject to transformation from knowledge-based economy to *creative economy* (Fanea-Ivanovici, 2013, p. 65-70). Elements of both economies can be a driving force for economic and social development, developing based on human knowledge and creativity, meaning that they can contribute to smart growth based on innovation and knowledge. In this approach, it is important to capture new and creative forms of knowledge creation. The arising new paradigm of economic development is based on the assumption that creativity, knowledge and availability of information are an important driving force for economic growth which supports development in the contemporary, globalised world.

Creativity is an important, interdisciplinary subject matter of studies, interesting from both the scientific and the economic practice perspective. In management studies, researchers more and more frequently consider creativity to be an important strategic element which may constitute an important source of competitive advantage formation (e.g. Dyduch, 2013; Bratnicka, 2010; Shalley, Zhou, and Oldham, 2004; Woodman, Sawyer, and Griffin, 1993, p. 293-321), which result in the accomplishment of high efficiency (Weinzimmer, Michel, and Franczak, 2011, p. 179-192). Creativity is most frequently analysed in the context of innovation, and perceived as a more efficient way of conducting business activity, inclusive of implementation of innovative processes. Thus, it may affect selection and development of smart specialisations. It is primarily related to generation of new, useful ideas pertaining to various processes and procedures applied within an organisation. Thus, it is of primary importance to innovation formation mechanisms. According to T. Amabile, creativity is treated as a trigger for innovation, and its occurrence is a function of existence of professional knowledge, task-oriented motivation and creative skills (Amabile, 1988). It may result in new ideas and concepts, original solutions and associations as well as interrelations between existing ideas and concepts, new interrelations between elements and their combination in an unprecedented manner, original responses, thoughts, or conclusions differing from contemporary standards (Matusiak, 2011). Therefore, it is important both at the stage of selection and at the stage of implementation of smart specialisation.

Creativity falls within the scope of the innovation theory which, in turn, falls within the scope of management sciences. Development of the *innovation theory* indicates continuous evolution of those phenomena, in particular in the context of globalisation developments and processes, with an ever increasing importance of knowledge, creativity and innovation. Today, these concepts are the most important keywords that are raised in both business practice and science throughout the world. Thus, they affect contemporary challenges related to smart growth. The nature and the way in which innovation is perceived have changed over the years. Not only importance of technological, i.e. product and process innovations, but also of organisational, marketing, social and ecological innovations which are of particular significance, given the priorities and the objectives of the Europe 2020 strategy, is stressed. The source literature emphasises that at present innovation results from involvement of a greater number of stakeholders than in the past; it results from the merging of a greater number of areas of knowledge which is developed within the framework of more diversified mechanisms and environments, where stronger than ever emphasis is put on, inter alia, personnel's autonomy, inciting creativity and mutual trust, communication and leadership (Kozłowski, 2013, p. 23).

In terms of smart specialisations, the construct of *technology creativity* that is a combination of organisational creativity and technology development is becoming particularly important (Kordel, and Machnik-Słomka, 2015, p. 163-178). Current literature covering technology creativity is most fragmentary and inconsistent. Technology creativity has been defined in the literature by several researchers, and it has been related to technological thinking and technological activity (Hyunjin Kwon, and Changyol Ryu). Technology creativity is defined as means with which people can apply knowledge in a better and more expedite manner, and thus improve the quality of life, in particular in the situation in which knowledge plays an ever greater role (Yu-Chu Yeh, and Jing-Jui Wu, 2006, p. 213-227). Thus, what distinguishes the work of technology from the overall area of creativity is the primary focus on technological thinking, technological activity and technological development. Technology creativity may, consequently, play a significant role in the implementation of one of the five assumptions of the 'National/Regional Innovation Strategies for Smart Specialisation' related to the support of technological and practical innovation. Technology creativity is a unique example of managers and employee teams' creative behaviours in which creatively developed technological innovations become the primary driving force of formation and development of contemporary organisations, and of creation of market values (Machnik-Słomka, 2015, p. 216-228).

Creativity and creative processes may thus contribute to greater efficiency of the processes of entrepreneurial discovery and learning for smart specialisations.

4. The role of universities in the development of smart specialisations

Universities ought to play a key role both in the process of selection and development of smart specialisations in cooperation with other stakeholders within the regional innovation system based on, inter alia, the triple (Bojar, and Bojar, 2009, p. 77-89), or the quadruple helix model (covering: the economic, the scientific and the public sector, the media, and users), concepts of the knowledge triangle (including: education, research and innovation), or by means of cooperation within networks and clusters. With respect to those ideas, universities serve a critical function, especially in terms of generating knowledge and using it to create innovative solutions in cooperation with other research centres and enterprises. Given the dominant 'market orientation', the role of users, or clients, is becoming a more and more important element of innovative processes.

Universities can contribute to regional innovation systems for smart specialisations through a series of mechanisms and instruments involving (Guide…, 2012):
- stimulation of the entrepreneurial spirit, innovation and creativity in their employees and students;
- offering advice and services to the economic sector, SMEs in particular;
- provision of experts working on identification and development of smart specialisation strategies in regions;
- participation in programmes promoting training and jobs for the best graduates with innovative companies;
- operation of academic entrepreneurship incubators as well as science and technology parks;
- active participation in operations of innovative clusters and networks;
- implementation of educational programmes and training addressed at various target groups in accordance with market demand;
- promotion of innovative solutions, also in smart specialisation areas;
- implementation of research projects within the framework of various research teams and consortia involving domestic and foreign partners;
- commercialisation of research results.

To achieve success in the field of smart growth strategy, it is important to convince all stakeholders that this is 'a collective social undertaking' based on the assumption that by working together they can accomplish more than by working separately (Guide…, 2012). Such cooperation is based on trust built on partners' reliability as well as observance and pursue of moral values (Stachowicz, and Stachowicz-Stanusch, 2011, p. 7-35). Description of the capacity-building processes and mechanisms as well as incentives for cooperation between universities and regional partners has been shown in a guide entitled '*Connecting*

universities to regional growth'. Among those mechanisms and processes, the following are listed (Guide…, 2012):

- establishment of a regional partnership for higher education in order to better understand the situation in the region and to overcome barriers;
- implementation of mechanisms with which universities and companies in the region can cooperate on the development of relevant curricula and carry out educational activities in an innovative way, providing graduates with competences needed in the region and with interdisciplinary skills, inclusive of the entrepreneurial and creative attitude;
- development of a map of a higher education system in the region that contains the following information: university entitlement to award degrees, research activity and potential cooperation with regional partners;
- evaluation of university cooperation with the public and the private sector in the region with a view to bringing about a situation in which universities are important stakeholders;
- selection, design and evaluation of interventions reinforcing university cooperation with other stakeholders in the region.

Thus, when designing and implementing educational programmes, universities ought to cooperate with external partners, companies in particular, so that graduates have relevant skills and competences which are consistent with market demands for smart specialisations. Due to the impact of innovative solutions on the broadly defined social dimension, the need to incorporate this dimension in university curricula, in particular technological university curricula (Kaźmierczak, 2014, p. 949-955), is stressed more and more frequently.

5. Creativity in terms of developing smart specialisations within the framework of university curricula

In the aspect of smart specialisations, there is a growing demand for creative thinking skills, ability to create new knowledge and to implement innovative solutions in practice. Consequently, curricula ought to be aligned with those needs and expectations, they ought to develop students' ability to effectively work in team, to manage team work, and to creatively solve problems in practice with the application of innovative creative thinking methods and techniques. These methods increase the efficiency of generating valuable ideas and problem solving by employees. Among these methods, one might highlight, for instance, brainstorming, mind maps, synectics, analogy method, system and algorithm methods like TRIZ (the Theory of Inventive Problem Solving) developed by Altshuller, or lateral thinking (developed by de Bono E.) (de Bono, 1970).

Curricula covering creativity for smart specialisations ought to be addressed at various groups:

– university employees – primarily with a view to their acquisition of knowledge and skills required to teach with the application of techniques and methods of creativity, and to apply them to research processes and innovative processes;

– students – so that they acquire competencies desired in the labour market, inter alia, with respect to idea generation and problem solving;

– entrepreneurs – by providing them with access to new knowledge and competences which are of use in their professional work and which may facilitate processes of creative generation of ideas, team work, etc.;

– primary and secondary school students – so that they acquire and develop independent thinking and creative problem solving skills.

In Poland, more and more programmes and projects are being implemented by universities in cooperation with relevant partners, related to creativity and its inclusion in educational programs, for instance the 'Academic Centres for Creativity' programme. It was a programme implemented by the Ministry of Science and Higher Educations, within the framework of which universities and schools carried out research into new teaching methods and techniques (http://www.nauka.gov.pl/…). Its assumptions included cooperation and development of relationships, opportunity to share academic teachers' knowledge, opportunity for students to use university laboratories, carrying out of classes to verify new educational methods in various scientific disciplines which might then be implemented and included in curricula (http://www.nauka.gov.pl/…). Most of those projects were designed to stimulate students' independent work, to develop their independent thinking and creative problem solving skills, and to increase their motivation to study. They were dominated by workshop methods which involved a greater number of students than traditional teaching methods. In that respect, other programmes initiated by the Ministry of Science and Higher Education, and involving, inter alia, development of model teacher training programmes, were also helpful. Examples of such programmes include the 'Development of model teacher training programmes' carried out within the framework of Action 3.1 Competences in higher education. Such programmes are supposed to allow for, inter alia, innovative teaching methods (learning-by-doing, design thinking), application of digital tools, development of social competences and competences regarding educational problem solving.

Examples of universities carrying out projects in that respect include the Silesian University of Technology which, among other things, carries out training courses for its lecturers within the framework of the 'Academic Teacher's Innovative Didactics' (https://www.polsl.pl/Wydzialy/RK…) project. The project is designed to provide participants with knowledge and skills regarding possible application of innovative teaching methods in higher education, knowledge regarding the use of heuristic methods, and ability to carry out classes with the application of student-activating methods. Another project carried out by the

Silesian University of Technology is the 'Silesian Human Resources for Innovative Entrepreneurship' project carried out within the framework of Action 11.3 RPO WSL (http://www.polsl.pl/Wydzialy/ROZ/roz2/…). It is aimed at increasing the level of professional competences desired in the regional (Silesian) labour market. Within the framework of the project, there are carried out training sessions designed for students of Silesian universities of technology and economics, and all persons who have graduated from them. The Silesian University of Technology also carries out a project called 'Creativity without barriers – University's third mission', whose leader is the Faculty of Organisation and Management of the Silesian University of Technology, working in cooperation with the City of Rybnik and the City of Zabrze (https://www.polsl.pl/Wydzialy/ROZ/Strony/...). The project is co-financed by the European Union within the framework of the European Social Fund with funds from the 'Copernicus Path 2.0' programme, as part of development of the University's offer regarding implementation of its third mission as a forum for social activity (Action 3.1 Competences in higher education, Axis III Higher education for economy and development, Operational Programme Knowledge Education Development 2014-2020). The project is aimed at secondary school students from the cities of Rybnik and Zabrze. Within the framework of the project, training courses are carried out in four thematic blocks. One of them concerns the carrying out of a workshop covering development of communication skills, critical and creative thinking, and problem-solving.

As the foregoing examples of projects carried out by the Silesian University of Technology show, they are carried out in cooperation with equal regional partners and addressed at different target groups. In addition, different faculties of the Silesian University of Technology carry out classes covering creativity and idea generation techniques. Implementation of those educational programmes and projects contributes to development of knowledge and competences regarding, inter alia, creativity, which may contribute to increased opportunities for the implementation of the regional strategies for smart specialisations. Also, the Silesian University of Technology has – since the very beginning – been actively involved in processes related to the formation and implementation of the Regional Innovation Strategy, working in cooperation with the Office of the Marshal of the Silesian Province and other regional partners.

6. Summary

With respect to smart specialisation strategy implementation instruments, one ought to highlight importance of promoting creativity. Given that smart specialisation is of crucial importance to effectiveness of research into and investments in innovation, creativity may play a significant role. Many researchers emphasise that creativity is an important strategic

element which contributes to greater efficiency. Thus, it may be perceived as a more efficient way of implementation of smart specialisation related projects.

The process of formation and development of smart specialisations depends on participation and involvement of various entities, inter alia, universities which ought to play a significant role in the alignment of curricula and development of science for smart specialisations. In order to develop smart specialisations, it is crucial to provide knowledge of creativity and to develop skills regarding the use of creative techniques which may facilitate processes aimed at creative idea generation and their development in innovative processes. Thus, university curricula ought to respond to social, economic and civilisational challenges. Science and higher education ought to support changes and developments in the environment by adjusting to the rapidly changing environment and contemporary challenges, that being smart growth based on knowledge and innovations.

The article contributes to further deliberations and research regarding relationships between creativity and development of smart specialisations.

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CONDITIONS OF INDIVIDUAL ENTREPRENEURSHIP IN THE OPINION OF THE INHABITANTS OF LUBLIN

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Abstract: The article discusses issues related to individual entrepreneurship. It is conditioned by a series of external (economic, political-legal, socio-cultural) and internal (individual characteristics) factors. The results of research conducted on the group of inhabitants of Lublin were presented in order to determine the factors which facilitated and hindered the establishment of one's own company. Starting up individual business activity is mainly facilitated by internal factors, while external factors make this process difficult.

Keywords: individual entrepreneurship, conditions of entrepreneurship.

1. Individual entrepreneurship

Entrepreneurship is a multidimensional concept covering a broad spectrum of issues. Entrepreneurial attitudes and behaviours, opportunities identification, using opportunities and the launch of new ventures, running a company and managing it to develop, implementing innovation, acting on its own, in a team or within an organisation, creating new values in different socio-economic spheres – these are just some of its aspects.

Individual entrepreneurship is when a business is undertaken by an individual on his or her own account and at his or her own risk, and he or she runs a business. This is the most discussed and analysed type of enterprise. S. Sudoł writes that the term "entrepreneurship" is primarily related to a single person, regardless of the circumstances concerning him/her, such as age, sex, nationality, education, occupation, or place in the social structure (Sudoł, 2008, p. 11). An individual entrepreneur runs his or her own business, bears all the responsibility (including financial) and risks associated with it, but also has all the benefits and profits. He or she should have relevant knowledge in all areas related to business activities (management, production, marketing, finance, logistics, etc.).

There are three groups of entrepreneurs who decide to start an individual business:

1) people who want to build a company from scratch, develop it by hiring employees, buying fixed assets, earn a living in that way and they derive professional satisfaction

(classic entrepreneurs). They set up a business primarily to make a profit. It is important for them to develop the company, to increase its potential and value; to achieve these goals they are able to give up their personal plans and dreams,

2) persons wishing to carry out their activity as a freelance profession for many clients using the freedom afforded by independent work organisation (lifestyle of an entrepreneur). Their key distinction is that they are motivated mainly by the desire to realise their dreams, vision, passion, and not a profit. They usually seek independence, sometimes they devote the development of activities for the realisation of their personal plans,

3) people who have switched from a full-time job to their own business, and the recipient of their company's services is the former employer (outsourcing entrepreneurs). They largely decide on how to do their tasks, so they can show more creativity and apply their ideas to organise their work, to cooperate with other entrepreneurs.

Ch. Karlsson, B. Johansson and R.R. Stough stresses that the motives of individual entrepreneurs from all three groups are not entirely different, but may be a mixture of economic and non-economic motives (Karlsson, Johansson, and Stough, 2014, p. 140-146). On the one hand, they perform management functions in the organisation, at the same time being its owners or co-owners, so they are capitalists – they get a return on their invested capital. On the other hand, as entrepreneurs-creators of new ideas, they should be rewarded for their initiation and implementation. In practice, however, it is impossible to separate these two roles (Gruszecki, 2002, p. 197).

Entrepreneurship is the result of the interaction of three variables: the ability to see people's opportunities, motivation and the chance to use that opportunity, and the environment in which they operate. Particular emphasis should be placed on the role of the last one. The external context has a significant impact on the willingness of people to engage in entrepreneurship, because they have to cope with innumerable conditions created by the environment.

Poland belongs to quite enterprising countries, characterised by a high percentage of entrepreneurs (15%) and people intending to start their own company in the next 3 years (20%), and a positive assessment of their own qualifications to establish their own company (56%). These results are above the EU average. On the other hand, Poland is less attractive in terms of European entrepreneurship when it comes to perceiving market opportunities for starting a business within the next 6 months at home. The dynamics of Polish entrepreneurship is still relatively high, and every year hundreds of thousands of people join the business circle. In this respect Poland is in the EU top (Tarnawa, and Skowrońska, 2016, p. 38-42).

2. The determinants of individual entrepreneurship

Entrepreneurship determinations create forces that are conducive to strengthening the entrepreneurial process and its results, and those that inhibit the process (Lichtarski, and Karaś, 2003, p. 23). They are often classified as external and internal, but their interactions are emphasised (Kraśnicka, 2002, p. 105-119; Piecuch, 2013, p. 82-111; Safin, 2003, p. 14). The most important **external factors** are environmental factors – economic, political-legal, and socio-cultural.

Economic conditions/factors are related to the functioning of mechanisms and market instruments. E. Rollnik-Sadowska divides them into three types: macroeconomic, concerning the labour market and workforce, and microeconomic (Rollnik-Sadowska, 2010, p. 27-38). Economic freedom (manifested in freedom of setting up a business activity and running a business), economic policy of the state, ownership structure of the economy, existence of a competitive market, stability of the financial, tax, and banking systems etc. contribute to the creation of entrepreneurial behaviours of entrepreneurs and citizens (Jędruchniewicz, 2011, p. 18-23).

Socio-cultural factors include a system of norms, beliefs, and traditions that apply in a given society. They contribute to the shaping of certain values related to prospective or retrospective orientation, competences or connections, individualism or collectivism, freedom of expression or trust, rigor of the code of ethics, or relaxation (Glinka, 2008, p. 10-14; Gołębiowski, 2008, p. 27-38; Rollnik-Sadowska, 2010, p. 40-46). In progressive and development cultures, the configuration of these values contributes to the modelling and empowerment of entrepreneurial attitudes. "Culture is the foundation upon which society operates in all its aspects. It is the basis of social life, which is the basis of the economic system, and consequently the development of entrepreneurship" according to R. Majkut (Majkut, 2014, p. 137).

Political and legal conditions create the assumptions of economic policies implemented by state and local authorities, the accepted ideology of governance, the efficiency of public institutions, the legal system, and the justice system. As entrepreneurship develops in a specific institutional and legal environment, these factors need to be stressed; they are the basis of all self-employment activity (Majkut, 2014, p. 100-123; Rollnik-Sadowska, 2010, p. 21-27). The role of the state is emphasised in a special way. It differs depending on the objectives set and the economic and social determinants – from inhibiting the development of entrepreneurship, through indifferent observation, to actively supporting it, and acceleration.

L.H. Haber adds another dimension – communicative, connected with the influence of the mass media (television, press, radio, Internet). With their help, from the local to global community, positive business models are promoted, examples to follow, educational and advisory information (Haber, 1996, p. 17).

The environment can create opportunities encouraging and facilitating entrepreneurial actions, as well as barriers, discouraging and hindering these actions. The need for observation of the environment by the entrepreneur is raised by J. Penc: the environment should be continually monitored, information on possible changes and tendencies in the environment should be collected and processed in order to be able to take full advantage of emerging opportunities, succeed in the marketplace and, if possible, also a competitive advantage (Penc, 2001, p. 180).

Internal factors in the case of individual entrepreneurship are dealt with by individual features, personal features of an entrepreneur such as personality characteristics, motives, value systems, knowledge, creativity, etc. T. Piecuch emphasises that it is not easy to quantify and verify them. The features that impede entrepreneurial activity include: submission, isolation from others, laziness, pessimism, difficulty in making decisions, concerns and fears, and a lack of mental immunity and vital energy. The facilitating features are: independence, ability to work with people, need for achievement, consistency in action, decisiveness, mental immunity, ability to work in difficult situations, intuition, vitality, creativity, and innovation. They should be the subject of specific analysis, because they often turn out to be decisive since they are "an important intangible force, an incentive, and a facilitator of the entrepreneurial initiative" (Piecuch, 2013, p. 86).

Entrepreneurship determinants are not universal in relation to the whole country. K. Zieliński draws attention to the need for analysing regional factors (Zieliński, 2014, p. 41-44). The Lublin Province since 2011 is on the penultimate, 15th place in annual rankings developed by the Polish Agency for Enterprise Development (PARP) (Tarnawa, and Skowrońska, 2016, p. 49). The city of Lublin is better off than the rest of the region. It should be noted, however, that for the development of entrepreneurship there are good conditions. They are created by a wealth of knowledge that allows for building a knowledge-based economy, intangible assets, new technologies, and especially human capital. Lublin is characterised by a good level of general education of the inhabitants and the qualifications of staff, developed higher education facilities, high scientific and research potential, relatively low labour costs, favourable geographic position on major transport routes linking Western and Eastern Europe (Mieszajkina, 2014, p. 53-61). However, it is perceived as a slightly peripheral city, attracting little interest of investors. Improving its image and competitiveness is possible through the development of entrepreneurship, active involvement of governments, business support organisations, and residents in the process.

3. Factors conducive to and hindering the establishment of one's own company in the opinion of Lublin residents

What encourages and what hinders the inhabitants of Lublin in establishing their own company? In order to answer this question, a survey was conducted between February and April 2015. The selection of the test sample was a deliberate quota sampling[1]. Residents of Lublin, conducting their own business activity or employed on a permanent basis were asked to fill in the questionnaire survey. The structure of people employed in the public and private sectors in the Lublin Province were considered: public and private sector (employed persons) – 73.1%, private sector: employers and self-employed – 26.9% (Aktywność…, 2015, p. 7). 100 questionnaires were distributed – 73 to employees and 27 – to business owners. 99 completed questionnaires were returned, of which 10 were rejected due to significant deficiencies in the answers provided. As a result, information from 89 respondents was used for the analysis. 24 persons (27%) are self-employed, 73% are full-time employed. The study involved 46 women and 43 men. These were mostly young people – 50 people aged 21-30, 19 people aged 31-40, 11 people aged 41-50 years and 9 people over 50 years old. The predominant participation of young people is due to the fact that most often young people start their own businesses. Possession of a Master's degree was declared by 36 respondents, bachelors or engineering – 18, meddle – 35.

The respondents were asked about the characteristics they think should characterise entrepreneurs and their degree of ownership. The ratings ranged from 1 to 5, where 1 means little importance, and 5 – high importance. The answers are included in Table 1.

Table 1.
Personality features of entrepreneurs

Feature	average degree/level	
	Degree/level of importance	Degree/level of importance
Diligence	4.66	4.33
Optimism	4.12	3.75
Ability to use emerging opportunities	4.27	3.45
Perseverance	4.61	3.96
Creativity	4.45	3.74
Ability to take risks	4.27	3.34
Honesty	4.26	4.46
Self-confidence	4.36	3.99
High professionalism	3.99	3.92
Tendency to charity	3.28	3.87
Insistence in pursuit of the goal	4.40	3.99

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[1] Quota sampling is based on knowledge of the general population structure. Samples that meet the desired characteristics are selected in such a way that their distribution in the sample corresponds to the distribution of these characteristics in the general population (http://www.bbm.com.pl/metodologia-badawcza/metody-doboru-proby-badawczej/. Available online 25.06.2015).

Independence	3.66	3.91
The desire to get rich	3.22	3.24
Manifesting the initiative	4.06	3.72
Ability to work with people	4.60	4.33

Note. Own study.

The most important traits to be characterised by entrepreneurial inhabitants of Lublin were: industriousness (4.66), persistence (4.61), ability to work with people (4.60), and creativity (4.45). The least important – willingness to get rich (3.22), tendency to charity (3.28), independence (3.66), and high professionalism (3.99). Among the characteristics of the average rating above 4 are: honesty (4.46), diligence (4.33), and ability to cooperate with people (4.33). The lowest scores were obtained by such attributes as: willingness to get rich (3.24), ability to take risks (3.34), and ability to use opportunities (3.45).

The next two questions were about the conducive and hindering aspects of starting a business. Answers were given on a scale of 1 (little importance) to 5 (high importance). This is presented in Table 2.

Table 2.

Features conducive to and hindering the establishment of one's own company

Features conducive		Features hindering	
feature	average grade/value	feature	average grade/value
Persistence and consistency in action	4.58	Laziness	4.34
Innovation and creativity	4.46	Lack of mental resistance	4.29
Independence of thinking, independence	4.31	Difficulties in making decisions	4.25
Ambition and the need for achievement	4.20	Problems communicating	4.19
Ability to learn	3.98	Pessimism	4.17
Risk inclination and courage	3.93	Lack of life energy	4.14
Readiness to compete	3.80	Difficulties in organising activities	3.97
Leadership	3.78	Lack of knowledge of running a business	3.95
Possessing managerial knowledge	3.58	Excessive caution	3.86

Note. Own study.

The respondents' responses show that being an entrepreneur requires a combination of perseverance with imagination, creativity, and with self-reliance and independence that will allow for ambitious goals. Little less do they appreciate the importance of learning and the ability to take risky and uncertain actions. Somewhat surprising is the low assessment of the usefulness of leadership and managerial skills that are essential to play an active role in one's business. Among the most disturbing qualities were laziness, passivity, and indecision, which are in fact incompatible with the entrepreneurial attitude. The negative impact of communication difficulties with other people, a pessimistic attitude to the world and the associated lack of willingness to act were also indicated. Less important obstacles in the respondents' opinion are problems related to possessing knowledge and managerial skills.

Then the respondents were asked if they had been considering starting their own business. 24 people already run their own business, 35 people are considering this opportunity in the near future, while 30 people are not going to become entrepreneurs. The last ones were asked

to give the main reasons why they did not want to start their own business. These are: no business ideas (9 people), there are no conditions for running a business in the Lublin region (4), lack of knowledge (4), satisfaction with full-time employment (4), lack of financial resources (3), too late due to age (3), fear of high risk (3).

Do the respondents consider the terms and conditions of running an individual business in Lublin as adequate? 9 people think that yes definitely, 33 – rather yes, 19 – not quite, 6 – definitely not, and 22 people do not have a say on this topic (these are people who do not intend to start their own company). The respondents also assessed their knowledge on institutions and business support programs on a scale of 1 (no knowledge) to 5 (they have extensive knowledge). It turned out that the best known solutions are entrepreneurial training (average rating 4.24) and educational programs (4.10). Knowledge on entrepreneurship incubators are insufficient (2.66). Consultancy provided by various institutions, agencies, state offices is little known, the average is 2.4. The least known solutions are technology parks (2.2) and business angels (1.92).

Residents who already run their own businesses were asked to indicate what motivates them to start their own business. The respondents assessed motives on a scale of 1 (little importance) to 5 (high importance). The results are as follows:

- independence, ambition, need for self-fulfilment – average rating 4.33,
- business idea – 4.0,
- additional income – 3.42,
- desire to get rich – 3.38,
- spotting a market gap – 2.92,
- no job offers – 2.25,
- loss of current employment – 2.0,
- grants for starting a business – 1.92,
- using EU assistance programs – 1.50,
- family tradition – 1.08.

The answer is that entrepreneurial activities were mainly undertaken caused by positive motives – willingness to be independent, realisation of own ideas for business, and self-realisation. EU support programs and business start up subsidies were rather a complementary stimulus. This is confirmed by answers to the question about the sources of financing, which entrepreneurs used to set up the company: own capital – 19 people, loan from family and friends – 9, credit – 5, EU funds – 2, and District Labour Office – 2.

The respondents-entrepreneurs were also asked to evaluate the barriers associated with starting a business on a scale of 1 (little importance) to 5 (high importance). The following average scores were obtained:

- frequent changes in the Polish law – 4.71,
- large taxes and fees – 4.67,

- risk apprehension – 3.79,
- bureaucracy accompanying the company – 3.71,
- difficulty entering the market, competition – 3.42,
- lack of capital to start up own business – 3.25,
- risk of loss in business – 3.13,
- inadequate knowledge of running a business – 3.08,
- volatility of demand – 2.88,
- lack of experience in running a company – 2.79,
- lack of confidence in business success – 2.54,
- fear of excessive time load – 2.46,
- difficulty obtaining a credit – 2.42.

Comparing the answers of the respondents employed on a regular basis and individual entrepreneurs, it should be noted that there are no fundamental differences. Among the mentioned factors conducive and hindering entrepreneurial activity in the first three places are the same answers, differing only in order, with mean scores being very similar. It should also be noted that the most optimistic persons are those who are just going to start a business, in comparison to existing entrepreneurs and people who do not intend to resign from the job. The same is true when evaluating the conditions for running one's own business in the Lublin Region. In the group of prospective entrepreneurs, young people are predominant, aged between 21 and 30 with a Master's degree.

Among people who do not intend to start their own business in the future, the main cause of reluctance depends on age. In the 21-30-year age group it is a lack of a business idea. The respondents aged 31-40 indicate mainly the lack of conditions for running their own business in the Lublin Region. Older respondents are satisfied with the job and they think the change is too late because of the age. It turned out that a lack of financial resources is not a major obstacle. Similarly, in the group of existing entrepreneurs, the main barriers when deciding to start a business are legal and administrative rather than financial.

Individuals who highly value entrepreneurial features (average 4.18) are most likely to start their own businesses. The average rating of own characteristics of respondents – entrepreneurs is slightly lower (4.05), while in the group of people who do not intend to start their own company the average rating is significantly lower (3.37).

4. Summary

J. Strojny and B. Stankiewicz treat entrepreneurship as a multidimensional phenomenon, distinguishing four dimensions: economic, social, organisational, and individual. In each of them there are phenomena and processes that condition its development. There are correlating positive relationships between these dimensions. The authors write: "However, it should be assumed that there is a mechanism of business acceleration causing, that the higher the level of entrepreneurship in one dimension, the higher the level of entrepreneurship in other dimensions" (Strojny, and Stankiewicz, 2009, p. 124). The respondents in the presented research do not assess the conditions for starting and running an individual business activity in Lublin very well. This causes more than 1/3 of the respondents not to become entrepreneurs.

T. Piecuch points out that when analysing the internal conditions of entrepreneurship, special attention is paid to the entrepreneur and his or her ability to overcome problems, difficulties, and deal with stress (Piecuch, 2013, p. 86). The respondents' answers confirmed that personality features have a significant impact on the decision to be an entrepreneur; they were first identified as the motivators for starting a business. However, in order for intentions to become acts, external conditions are necessary. They are related to market mechanisms, primarily of stability, as well as the development of banking, financial, tax, and customs systems. They serve as stimulants both in the initiation, conduct, or development of entrepreneurship (Piecuch, 2013, p. 83). The research presented in the article shows that factors conducive to starting an individual business activity are mainly internal factors, or the personality and psychological characteristics of the respondents, their desire to be independent and to realise their own business ideas. The external factors, above all legal and economic, make this process difficult.

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FORECASTING THE NUMBER OF PASSENGERS SERVICED AT THE MARITIME PORTS IN BULGARIA

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Abstract: The maritime transport in Bulgaria is controlled and coordinated by the Executive Agency "Maritime administration". This institutionis a legal entity on budget support to the Ministry of transport, information technology and communications, a second level user of budget credits, based in Sofia with regional offices in Bourgas, Varna, Lom and Rousse (where are the Bulgarian major ports). EAMA status is regulated by the Merchant Shipping Code – Art. 360, para. 1. The problem of forecasting in the new strategic documents is crucial to the formation of proper infrastructure policy which has to be innovative and for the future strategic development of the tourism in the country.

This paper is aimed at presenting the lack of real forecasting in many of the strategic documents and projects adopted for the development of the maritime transport in Bulgaria (i.e. Directive2008/106/EC of European Parliament and Council on the minimum level of training of sea farers; Ordinance No. 9 of 2013 on the requirements for operational suitability of ports and specialised port facilities; Ordinance No. 10 of 2014 on the scope and content, preparation, approval and amendment of the general plans of the public transport ports). There are also many Mutual Agreements for Recognition of Seafarers" certificates**.**

The paper provides a practical example for the use of the so called single or simple exponential smoothing without the presence of any seasonality and the lack of cyclicity on the number of passengersarrivals at the Bulgarian maritime ports.

Keywords: maritime transport, forecasting passengers, sea ports, single or simple exponential smoothing method, strategic documents.

1. Introduction

The maritime transport in Bulgaria is controlled and coordinated by the **Executive Agency "Maritime administration"**. This transport and its infrastructure are put under serious pressure in connection with the membership of Bulgaria in the European Union. The problem of forecasting in the new strategic documents is crucial tothe formation ofproper innovation infrastructure policyfor thefuturedevelopment of thetourism in the country. This paper is aimed at presenting the lack of real forecasting in many of the strategic documents and projects adopted for the development of the maritime transport in Bulgaria. A possible solution can be

found in the group of the exponential forecasting methods and in particular in the face of the Single or simple exponential smoothing method. This method is explicitly suitable for forecasting and planning of the maritime transport infrastructure, as it can provide considerably reliable forecast values on the number of passenger arrivals of some of the country's major maritime ports, such as the Varna and Burgas ports which are under review in the present article. As it is seen from the statistical yearly records of the passengers flows on the Bulgarian maritime ports, the number of passengers is slowly decreasing within the period from 1999 to 2007 (Table 1). This decrease however is accompanied with the lack of any cyclicity and seasonality (Fig. 1). Forecastofthe number ofpassengers servedbyBulgarianmaritime portsbymaritime transport applying the methods described in this article is presented in fig. 1 and table 1.

Table 1.
Number of passengers served by Bulgarian maritime transport

Years	Number of passengers-thousands
1990	26
1991	13
1992	11
1993	11
1994	10
1995	10
1996	11
1997	60
1998	86
1999	121
2000	76,0
2001	67,0
2002	60,0
2003	73,0
2004	81,0
2005	80,0
2006	75,0
2007	232,0
2008	246,0
2009	237,0
2010	149,0
2011	162,0
2012	175,0
2013	143,0
2014	90.0

Note. Mirchova, S. (2014) from the NSI (National Statistical Institute).

As is clear from the presented graphically time series corresponds to the same forecast profile with a lack of any trend and no cyclicity and seasonality that is the so called forecast profile type (N, N model) corresponding to the Single exponential smoothing method, also known as Simple exponential smoothing method.
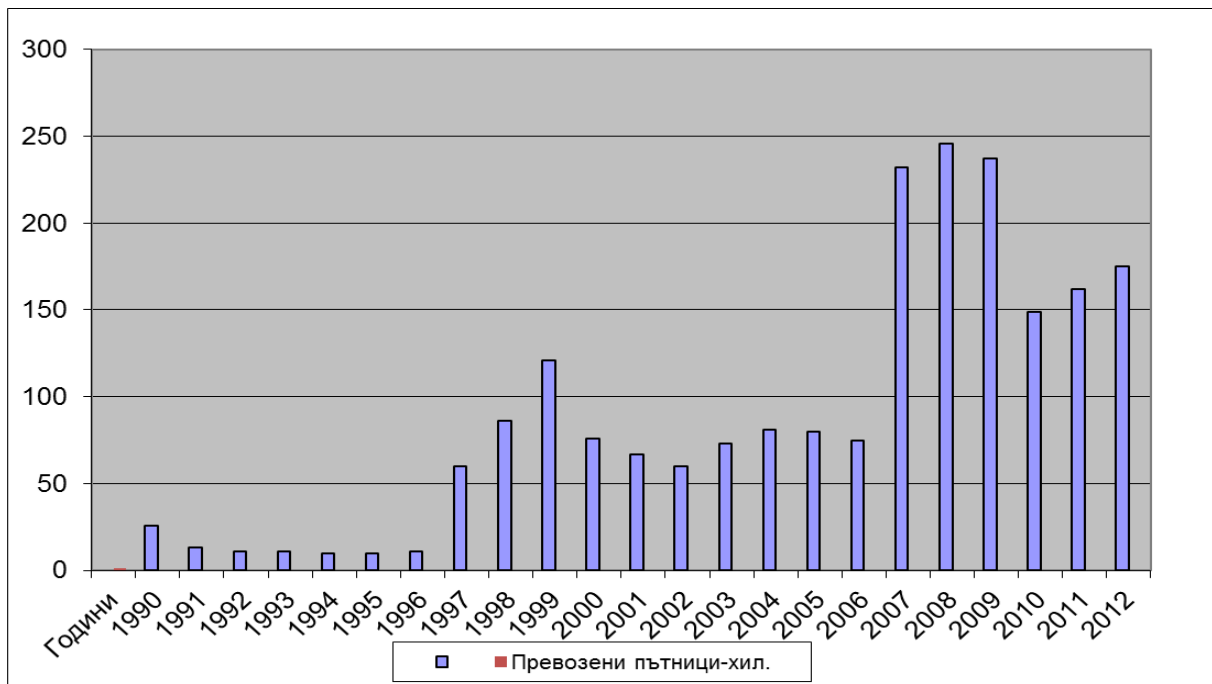
Figure 1. Number of passengers served at the Bulgarian maritime ports. Note. Mirchova, S. (2014) from the NSI (National Statistical Institute).

2. Objectives

As P. Dimitrov (2011, 2012) points out the task of creating an exponential smoothing forecast model for the long-run development of the tourism industry, and in a particular for the Bulgarian maritime ports, meets with solving of several major problems:

1. Finding of a suitable general indicator, on the basis of which to build the long-run forecasts (the forecast for periods longer than 5 years).
2. Determining the time series pattern, or the so-called "forecast profile" (Gardner, 1987, p. 174-175) (Hyndman, Koehler, Ord, and Snyder, 2008, p. 11, 23) and the quality of the data in the pattern, on the basis of which to select the suitable forecasting exponential smoothing model.
3. Selecting and using of suitable forecasting techniques.
4. Calculating of long-run forecasts for the value of the above-mentioned general indicator (up to the year 2025).

3. Methodology and main results

With regards to the first problem, i.e. the finding of a general suitable indicator, on the basis of which to make the forecast, it can be pointed out that the Bulgarian maritime ports have published their yearly statistical records of serviced passengers, already presented in point 1 of the present article.

The second problem of determining the times series pattern, or the so-called times series' "forecast profile" is usually solved by comparing the times series in regard with a pre-set classification of exponential smoothing methods or the derived from them forecast profiles in terms of development curves. As Hyndman, Koehler, Ord and Snyder point out (Hyndman et al., 2008, p. 11-12), this classification of smoothing methods originated with Pegles' taxonomy (Pegles, 1969, p. 311-315). This was later extended by Gardner (Gardner, 1985, p. 1-28) and modified by Hyndman et al. (2002, 2008) and extended by Taylor (Taylor, 2003, p. 715-725) giving a classification set of fifteen models. In the regarded time series, as it will become later clear, the Gardner's much simplified classification can also be successfully used for finding the best fit forecasting method or forecast profile. The finding that the time series of the number of the passengers serviced at the Bulgarian maritime ports for the time period 2000-2014 corresponds to the "exponential trend, no seasonality" profile and requires the "A, N" variation of exponential forecasting methods makes the third problem, the one of selecting and using of a suitable forecasting exponential smoothing method much more predetermined and easier to solve. This profile corresponds to the method of single exponential smoothing with a lack of a ciclicity and seasonality, also known as the Simple exponential method.

Table 2.
Description of the parameters of the prediction model used to calculate the estimates for the total number of passengers served by maritime transport Single exponential method calculated with software "STATISTICA" ®

	Exp. smoothing: S0=36,77 T0=,5000 (Spreadsheet1MOrs Expon.trend,no season; Alpha= 1,00 Gamma=,041 VAR2	
Summary of error	Error	
Mean error	15,445137403	
Mean absolute error	24,892893794	
Sums of squares	44168,51181820:	
Mean square	1920,370079052	
Mean percentage error	22,693186102	
Mean abs. perc. error	30,613545704	

Note. Mirchova, S. (2014) from the NSI (National Statistical Institute).

Figure 2. Graphical representation of the time series for the total number of passengers served by maritime transport. Note. Mirchova, S. (2014) from the NSI (National Statistical Institute).
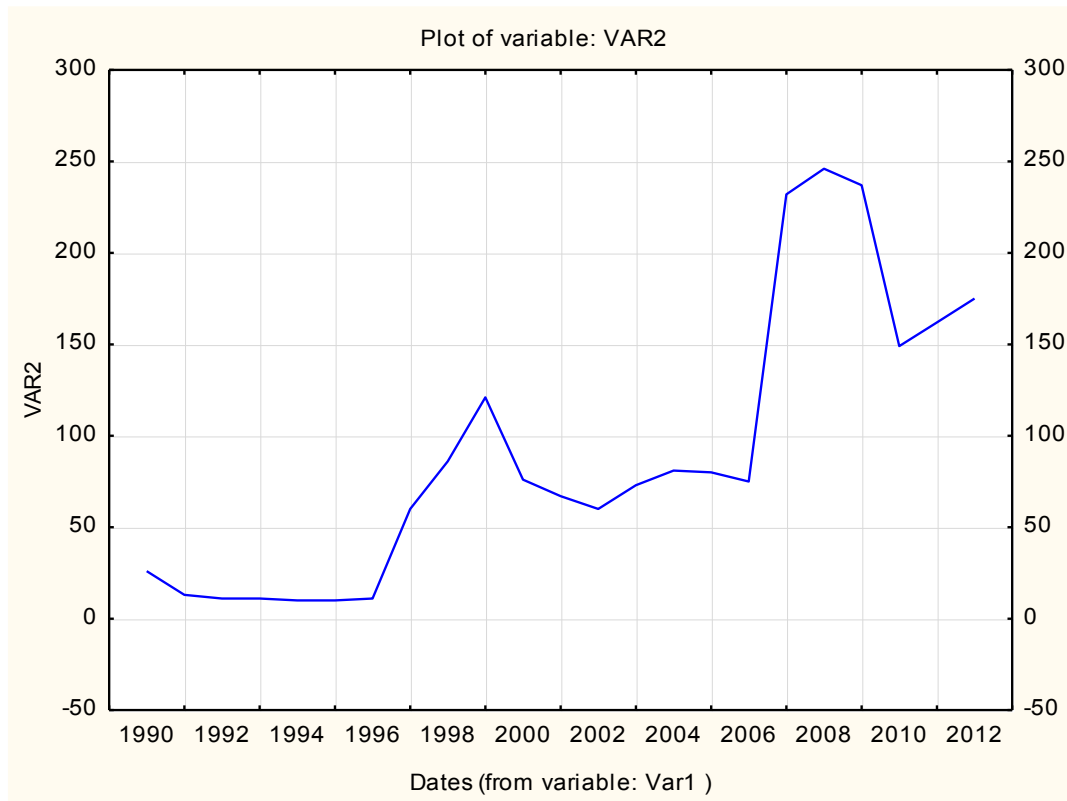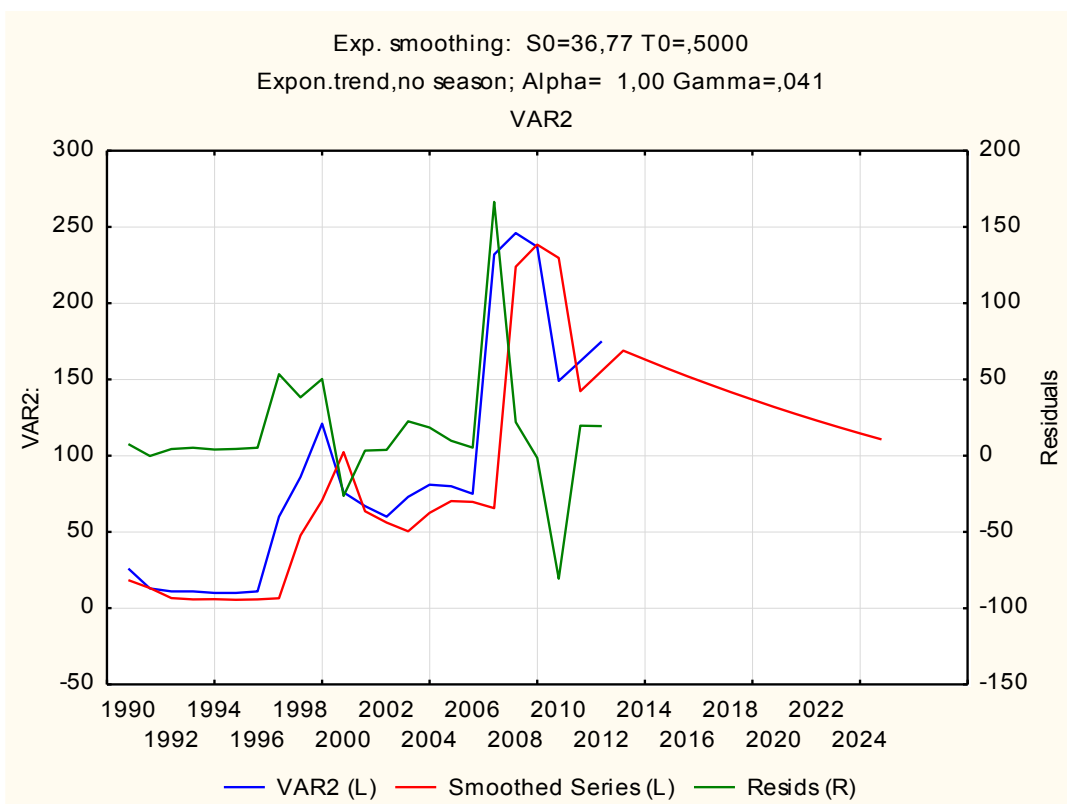

Figure 3. Graphical representations of time series for the total number of passengers served by maritime transport, projected results and the absolute amount of errors in forecasts. Note. Mirchova, S. (2014) from the NSI (National Statistical Institute).

Table 3.

Estimated value and errors in estimates of the number of passengers served by maritime transport for the period 1990-2025, with software "STATISTICA" ®.

Var1 (Dates)	Exp. smoothing: S0=36,77 T0=,5000 (Spreadsheet1MOrs Expon.trend,no season; Alpha= 1,00 Gamma=,041 VAR2		
	VAR2	Smoothed Series	Resids
1990	26,0000	18,3848	7,6152
1991	13,0000	13,2208	-0,2208
1992	11,0000	6,6059	4,3941
1993	11,0000	5,7420	5,2580
1994	10,0000	5,9576	4,0424
1995	10,0000	5,5667	4,4333
1996	11,0000	5,7484	5,2516
1997	60,0000	6,5601	53,4399
1998	86,0000	47,7336	38,2664
1999	121,0000	70,6669	50,3331
2000	76,0000	102,3302	-26,3302
2001	67,0000	63,5955	3,4045
2002	60,0000	56,1875	3,8125
2003	73,0000	50,4571	22,5429
2004	81,0000	62,5140	18,4860
2005	80,0000	70,2059	9,7941
2006	75,0000	69,7357	5,2643
2007	232,0000	65,5796	166,4204
2008	246,0000	223,9661	22,0339
2009	237,0000	238,4392	-1,4392
2010	149,0000	229,6590	-80,6590
2011	162,0000	142,3057	19,6943
2012	175,0000	155,5995	19,4005
2013		168,9451	
2014		163,0998	
2015		157,4566	
2016		152,0088	
2017		146,7494	
2018		141,6720	
2019		136,7702	
2020		132,0381	
2021		127,4697	
2022		123,0593	
2023		118,8016	
2024		114,6911	
2025		110,7229	

Note. Mirchova, S. (2014) from the NSI (National Statistical Institute).

As we apply the methodology for forecasting with the single exponential smoothing without the seasonality and the absence of cycling seems highly negative trend to reduce future projections. After 2015 they became negative. The case is to score the number of serviced passengers so it cannot take negative values. We can reach the conclusion that if the existing processes and factors affecting the development of time series continue, it is possible to reach

out a drastic reduction in the number of passengers served and practically the sub-sector will collapse in the long run period.

It is clear also that the – lowest estimate in the forecast model in 2015 is 157.4566 persons served passengers. And the last realistic value for the previous 2014 shows that the number is 163.0998. Reported estimated value for 2025 is 110.7229.

4. Conclusions

The forecast results achieved through the Single exponential method for the annual data of the number of the passengers serviced at the Bulgarian maritime ports and the lack of a steady trend of annual decrease show out that there will be a constant decrease of the number of the passengers up to the end of the year 2025. Presented charts and tables also show that the lowest estimation in the forecast model in 2015 was 157.4566 passengers served. The last realistic value for the previous 2014 is 163.0998. The highest estimation to 2025 is 110.7229 passengers' served by Bulgarian maritime ports. Based on the achieved forecast values in Table 2 and fig. 3, we can conclude that the variation in the number of the serviced passengers on the Bulgarian maritime ports will remain steadily decreasing. This strongly requires a change in the policy of infrastructure investment of the maritime authorities, if they would like to achieve a steadier trend of increase and overcoming this trend they should take really serious actions. On the basis of the assessments made on the transport infrastructure in Bulgaria on different modes of transport, concrete actions can also be taken to increase their competitiveness. These actions can also be structured in the form of a strategy to increase competitiveness, and a key element in this strategy should be to increase the number of passengers. It is in this way that uniform distribution of passengers can be achieved and that congestion on one mode of transport will be avoided at the expense of other modes of transport. A strategy to increase competitiveness by increasing the number of passengers is also in line with the European Union policy to promote a balanced development in the transport sector in Bulgaria. The participation of Bulgaria in the TINA project is an important element of the development of the transport infrastructure. For Bulgaria, the network is specified on the sections of the five Trans-European Transport Corridors passing through the territory of the country. The value of matching the core network in Bulgaria to EU standards is estimated at EUR 4095 million, of which EUR 2165 million for the road network and EUR 1930 million for the rail network compared to the National Transport Strategy. The European Union finances projects for which Member States have agreed that together they can achieve better results at a lower cost. Under these conditions, the border regions of Bulgaria and Greece, Turkey, Romania, Serbia and Macedonia could implement a joint strategy to increase the number of passengers from different types of transport infrastructure through joint projects related to the development and improvement of the road,

rail, ports and airports infrastructure. In Bulgarian transport policy the maritime transport should be main priority to increase the number of passengers served by Bulgarian maritime ports. To achieve this goal there should be taken some actions:

Action 1. Improving the infrastructure of Bulgarian seaports through upgrade and modernization of the existing ones.
Step 1. Renovation of port complexes with piers and places that specialize in different types of cargo;
Step 2. Improving the system for traffic management of the vessels;
Step 3. Development of intermodal transport systems and modern logistics centers;
Step 4. Targeting the transport policy in development of maritime and river transport instead the road transport;
Step 5. Assistance by the new financial instrument "tool linked Europe" by the EU Cohesion Fund and by OP "Transport";
Step 6. Expand the number and capacity of ferry connections of our two major ports of Varna and Burgas;
Step 7. Completing the existing radar system;
Step 8. Expand the existing telecommunications subsystem;
Step 9. Purchase of hardware and software;
Step 10. Expanding the number and capacity of ferry connections of our two major ports of Varna and Burgas.

Note. Mirchova, S. (2014).

Following the logical framework of the strategy can be said that the vision of the strategy is the sustainable development of the transport sector in Bulgaria. The main strategic goal is to increase the number of serviced passengers from different types of infrastructure in Bulgaria by undertaking specific actions and steps for their realization. Even if only 1% of journeys, for example by road or bus transport, are replaced by a so-called "green transport" trip, this will increase the number of passengers and would mean reducing the bad environmental consequences. What would happen if a comprehensive transport infrastructure that offers development of all modes of transport attracts 10% or 20% of the number of pedestrians crossing Bulgarian terminals, railway stations, ports and airports?

STRATEGY FOR THE INCREASE IN THE NUMBER OF PERSONS OF THE DIFFERENT TYPES OF INFRASTRUCTURE IN BULGARIA:
1. Increasing the number of serviced passengers at the Bulgarian bus stations.
2. Increasing the number of passengers benefiting from road transport.
3. Increasing the number of serviced passengers on the Bulgarian railway stations.
4. Increasing the number of serviced passengers on Bulgarian river ports.
5. Increasing the number of serviced passengers on Bulgarian seaports.
6. Increasing the number of serviced passengers at the Bulgarian airports.

Note. Mirchova, S. (2014).

The current strategy to increase the number of passengers served by the different types of infrastructure in Bulgaria shows the need to implement a set of actions, some of which require a change of approach, a more efficient organization of work, new partnerships. However, other actions involve investing in technical equipment, equipment or human resources. The possible funding sources for these actions can be public, private and EU-funded. The expected main

results of the implementation of the strategy are increasing the number of serviced passengers from different types of infrastructure in Bulgaria, such as developing the local economy, improving and facilitating the access of local residents to transport services and attracting new passengers passing through the territory of Bulgaria and using the transport infrastructure of our country.

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SELECTED ASPECTS OF AUSTRIAN-POLISH COOPERATION IN THE INNOVATION OF ENTERPRISES

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Abstract: The article analyses issues of innovation by small and medium-sized businesses in Poland and Austria in the context of the Europe 2020 Strategy. Polish cooperation with Austria is visible mainly in the fields of innovative solutions, nature protection, efficient production and respect for natural resources, which significantly affects sustainable economic development and job growth in both countries. In addition, the countries are connected with respect to economic growth and issues related to the exploitation of natural resources, which are key for the protection of the environment. Related decisions and actions in the near future will have a significant impact on the performance and economic cooperation of the two countries.

Keywords: innovation, cooperation, Europe 2020 Strategy.

1. Introduction

The history of Austria and Poland shows links of close cooperation. Economic relations between Poland and Austria solidified when Poland acceded to the Union on 16 April 2003. Agreements between Poland and Austria during the pre-accession period include those regarding cooperation in the economic, technical and technological fields of October 1995, investment promotion and protection of November 1988, and avoidance of double taxation on income and assets, later amended in January 2004 and February 2008 and entered into force in October 2008[1].

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[1] Poland-Austria Business Leader is an initiative that highlights and rewards the best Polish entrepreneurs operating in Austria. Inter alia, it strengthens Poland's economic connections with Austria by integrating the Polish business environment and promoting Polish entrepreneurship and products in Austria. It also summarizes achievements and reflects on future development. The established position and achievements of Polish entrepreneurs in Austria allow us to hope that their activities will continue to grow, thereby strengthening bilateral relations and building a positive image of Poles in Austria. The promotional project "Business Leader of Poland-Austria", selecting winners for reward motivates companies to brave the difficult and demanding Polish community action in the Austrian market. Awards, trophies and the participation of Austrian guests of honor also notifies local economic authorities that Polish companies operating in Austria have competitive products and are modern and in many cases likely to be successful in the local market. The Vienna Chamber of Commerce (WKO) is involved in this year's festivities, as the ceremony is performed at its headquarters.

Austria is proud to have a strong presence in Polish economic life. Austrian companies create approximately 45 000 jobs in Poland. The voivodeship of Greater Poland is one of the regions that most strongly cooperates with Austria, with 415 Austrian companies producing a value of trade ranking third among all Polish regions. Approximately 40 Austrian companies are headquartered there. On 22 May 2014, the Austria and Polish Business Gala took place with the participation of 100 guests; it was organized by the editors of Polonika in cooperation with the Vienna headquarters of WPHI Chamber of Commerce (WKO Wien) and was dedicated to the tenth edition of the contest Business Leader Poland-Austria (Top Unternehmen Polen – Österreich 2014) (https://wien.trade.gov.pl/…).

The priority actions in cooperation with the Europe 2020 strategy include transfer of knowledge, protection of the environment and sustainable development. Both Poland and Austria have a high level of unemployment (http://www.umww.pl/…). The Polish people, as well as nationals of other countries of the Union, may work in Austria without a license but are subject to certain conditions, in accordance with the law introduced on 1 May 2011 against wage and social dumping (Lohn- und Sozialdumping-Bekämpfungsgesetz or LSDB-G). The Act introduces the catch rates and mandatory social insurance rates for employees of the aforementioned countries with existing native Austrian workers. The wage rates of Austrian employees are determined by the relevant laws, regulations or collective agreements (collective wage tariff agreement) concluded by individual employers.

The Europe 2020 strategy is based on activities at the national level and possible European support. This progress in reducing the distance between Poland and more developed EU countries (including Austria) is linked with mobilizing system reform on investment in knowledge and making structural changes towards creating a stronger economy. As outlined in the European Commission's communication on the state of innovation in the European Union, effective innovation policy requires several essential elements: Europe needs reform in the field of investment and transformation in its turbulent environment (Jasiński, 2010; https://wien.trade.gov.pl/…).

Today's business is closely linked to globalization and internationalization, as the market is the place where many different links to international markets are located. Recent years have been an increase in interest in the effectiveness of innovative processes, as a determinant of the competitiveness of companies operating in the international arena. The innovativeness of enterprises is, among others as a result of growing domestic and international competition, as well as the need to reduce production costs, while maintaining the quality of production and the level of consumer satisfaction. The idea of increasing innovation in the context of the cooperation of many companies located on different national markets is becoming increasingly important and it becomes an opportunity to optimize the use of resources and increase their competitiveness in the market.

This paper deals with issues related to selected factors of the enterprise innovation chain in Poland and Austria, with particular emphasis on their cooperation and the impact of other external factors on competitiveness. The process of cooperation between the various entities and organizations located in these countries has been analyzed in detail, from the point of view of the synergy that can be observed in the work of every modern group of organizations and the necessary condition for its development.

The literature on the subject often points to the need for companies to adapt to external trends in the area of innovation (Stachowicz-Stanush, and Sworowska, 2014, p. 138; Stawiarska, 2015, p. 128). Innovative processes refer to the efficiency of the chain of cooperating enterprises, as well as the processes of cooperation that will in the future be a survival in a competitive market. According to many authors cited in this paper, the innovation of the enterprise chain and its links significantly affect the level of economic development of countries and regions. Hence, the analysis of the processes of co-operation in the chain is reflected in many research papers and scientific papers (Kordel, and Machnik-Słomka, 2015, p. 166). The issue of examining the proper relationships, relationships and relationships between the actors involved in the innovation chain is becoming an important scientific issue. From the point of view of effective management, the flows in the innovation chain need to be systematically reviewed so that effective collaboration within the group is superior to that of the innovation actors without reference to competition and business partners. The complexity of the relationship and the multiplicity of links between the links of the innovation chain determine the methods that can be used in the management processes (Szwajca, 2014, p. 100).

Creating a chain of organizations, especially in markets located within short distances and having a tradition of mutual cooperation, gives the opportunity to develop innovation also in small entities, which can make them more competitive on the local or national market. In the presented work the focus was on the innovativeness realized in the area of cooperation between Polish and Austrian companies, which takes on a systemic form. Such forms of business cooperation require the ability to manage not only material resources, but also people and their knowledge. Team innovation, realized within the concept of a chain of relationships, consists of vertical or horizontal integration, and each of these forms also involves the management of people. Essential in this area is knowledge of formulation of teams and knowledge of the functioning of social groups and intangible resources located in them.

One of the most important determinants of the development of innovativeness within the framework of cooperation between Polish and Austrian companies is the functioning of a network of institutions and organizations providing comprehensive services and assistance in the field of advisory, information and financial support for initiatives undertaken by enterprises. The analysis of enterprise innovation in Poland and Austria shows that it is based mainly on the functioning of small and medium enterprises. Their ability to respond flexibly to changes in the socioeconomic environment means that the development of this sector should be the main objective of institutional support (Zawada, Pabian, Bylok, and Cichobłaziński, 2015, p. 7).

Examples of various types of cooperation presented in the publication point to a very wide use of it. It can be based on the integration processes of various institutions and organizations working for the development of economic cooperation. In Europe, as well as in Poland, a number of actions are being carried out based on the cooperation of enterprises and institutions, aimed at improving the quality and development of entrepreneurship.

One of the conditions for effective management of the innovation network (Skowron-Grabowska, Seroka-Stolka, Wójcik-Mazur, Surowiec, and Piertasieński, 2017) is the availability of up-to-date information and knowledge. Therefore, a lot of work was devoted to knowledge and its role in the development of the network of organizations in the field of cooperation between Polish and Austrian institutions. Knowledge management in every organization is primarily aimed at transforming knowledge hidden in open knowledge. This is especially important in organizations' networks that interact with each other in different tasks. In such a network there is the possibility of exchanging information and knowledge, the participants of this process can learn each other and carry out the processes of codification of hidden knowledge, which is in the minds of people and is not widely available. Hidden knowledge results from our experiences, observations, innate talents, predispositions and intuitive thinking. Only teamwork (cooperation) allows for the exchange and codification of hidden knowledge. It is not just cooperation in the implementation of various economic processes, but, above all, the exchange of information and knowledge (Brzostek, and Michna, 2015, p. 53).

Eliminating barriers to knowledge management in various forms of cooperation between Polish and Austrian companies is a challenge not only for entrepreneurs themselves, but also for other actors participating in the exchange process.

Therefore, it can be stated that there are many conditions for creation and management of innovation networks in the activities of Polish and Austrian companies. External conditions such as globalization and dynamic economic development affecting changes in communication, competitors and thus co-operation between entities, financing / co-financing of various projects, etc., can be identified, such as: local conditions, geographic determinants, In the process of creating and managing innovation networks, it is very important to take into consideration internal conditions, understood as the knowledge and skills of people involved in innovation processes, the network structure of cooperating enterprises (the more links the greater the stability of the networks) well defined rules of its functioning.

2. Polish and Austrian ties in economic and trade cooperation

The Polish accession to the European Union in 2004 boosted the dynamics and structure of trade in goods between Poland and Austria. Unfortunately, the financial crisis of 2009 stopped a phenomenon of growth and reduced the dynamic bilateral trade in goods. There was significant improvement in the trade activities in 2010, 2011 and 2012 as turnover indicators to trade increased. Eight hundred Austrian companies are represented in Poland. The data of the Austrian National Bank show that the accumulative value of Austrian direct investments in Poland at the end of 2011 was approximately 3.68 billion euros. This result ranks Austria 10th among foreign investors in Poland. The figures for 2011 indicate a withdrawal of investment capital in Poland totalling 95 million euros. The actual value of Austrian investment in Poland, however, may differ from these values because Polish statistics include only investments above 1 million euros (Sikorska, 2000, p. 34-41).

According to a recent report on the cooperation between the two countries, at least 40 Austrian companies lead investment activities in Poland, each investing a minimum of $1 million. The largest Austrian investors include Europolis real estate, Bau Holding Strabag AG invested in hotels and office buildings, Raiffeisen Zentralbank, Rigips Austria GmbH and Leier involved in building materials, Wienerberger in ceramics, Porr International Hotels, Henkel CEE in chemicals, Kronospan in the production of particle board and some insurance companies, such as Uniqa, Generali and Wüstenrot, and Vienna Insurance Group. Compared to other States in the region, Poland is also an attractive and promising investment destination for small and medium-sized enterprises (SMEs) from Austria. These are mainly involved in energy industries, environmental technologies, infrastructure and the construction industry, as well as consumer goods (Celuch, and Dziedzic, 2012; https://www.atn.edu.au/…). It can therefore be seen that Austrian companies show great interest in the economic activity in Poland.

3. International cooperation of Polish tourists/guests in Austria

Poles' international travel indicates their country's dynamic growth. According to studies carried out in January 2015 by the UNWTO World Tourism Barometer, it is estimated that global travel will increase from 1138 in 2014 to 1800 in 2030, as shown in Figure 1.
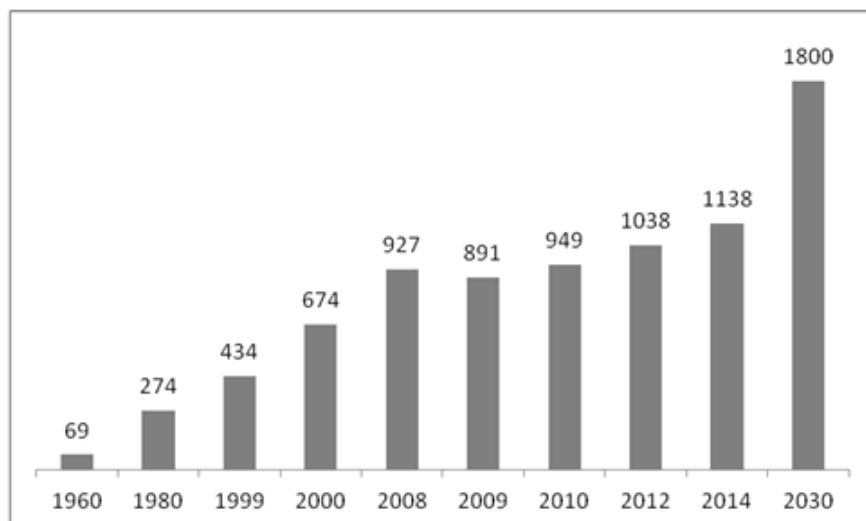
Figure 1. Potential development of international tourism. Note. UNWTO, World Tourism Barometer January 2015 2030 = Langfristprognose lt. Tourism 2030 Vision der UNWTO.

Polish people increasingly travel to Austria, especially in the winter, when they visit the mountains. According to Austrian statistics, in 2015, the use of the tourist attractions increased by more than 30% compared to the previous year. The use of accommodations in Austria rose by 13% from 2009 to 2013 and fell by 0.5% in 2014 (UNWTO…). In the long term, Polish tourists trips to Austria appear to be on the rise. Polish travel to Austria strengthens various relationships, including those associated with economic projects and new business contacts. This increased cooperation between Austrian and Polish individuals can create synergies and lead to mutual development.

4. Problems of Austrian-Polish cooperation in innovation of enterprises

Innovation is a competitive strategy used by both small and large companies. Different activities indicate their specific characteristics, such as size or heterogeneity. In large companies in any country, the technological level tends to be greater than in smaller companies. SMEs usually do not have sufficient potential to increase their innovation, and they often seek to increase innovation in terms of products, although they should instead focus on technological innovation and cost reduction to meet the competition (Tödtling, 2013, p. 190-194).

Polish SMEs in Austria have to overcome limited innovation. Research conducted across Europe indicates that funding sources are a common cause for lack of innovation in Poland and other countries. Sometimes, lack of innovation can become a vicious problem. Funding is available to innovative projects in Poland and Austria, but small projects are less noticeable and unfunded because they are often regarded as not technologically advanced. Remote regions in both Poland and Austria cooperate less, which may impact innovation and lead to organizational

and technological shortcomings. The most serious problem impacting innovation is the low awareness of entrepreneurs and clients in this area (James, and Roper, 2015, p. 29-31).

Sometimes, customers resist innovation because they prefer to use familiar and proven solutions and know that new development may increase prices. Price competition does not limit innovation.

Despite the economic union between Austria and Poland, there remain barriers to cooperation projects. Innovation often lacks support from coherent policy in identifying and executing research projects. A study linked to an evaluation of innovation supporting SMEPOL notes that some regions, such as Upper Austria, should be more involved in support of innovation and joint ventures among SMEs (Teppo, and Zenger, 2014, p. 916-918).

5. Innovation on the Austrian market

Austria has a wide range of strengths, but it is limited by small financial support from the European Union. There is much potential for innovation in Upper Austria, as well as in several smaller industrial centres. The traditional fields of industry are manufacturing, transportation, mining and chemicals. Austria is active in terms of industrial and technological innovation (Tödtling, 2013, p. 188-205).

Scientific units, particularly universities, are important for innovation in Austria. Most scientific research is carried out in Vienna and Graz, but there are also smaller units of regional scientific potential to initiate and implement innovation in enterprises (Kraus, 2013, p. 428-430).

In 2012, a study on 324 companies in manufacturing and services located in Upper Austria, indicated that 140 of them can be classified as SMEs. The size distribution of firms (in terms of employment) in the sample of respondents corresponds to the regional economies. Due to the diversity of the SME sector, there is little opportunity to establish a single innovative aspect to meet the needs of all SMEs. The study observes that the average budget for innovation in marketing is 14.0%, and the average percent of total staff involved in innovation is 18.6% in the case of SMEs. Large companies, by comparison, have average ratios of 11.3% and 9.4%, respectively. SMEs usually are not organized in a way that allows them to benefit from expertise in the same way as a larger company. This is a significant disadvantage as small companies are particularly vulnerable to failure in the face of limited resources (Tödtling, 2013, p. 188-205).

SMEs are less likely to engage in research than large companies. Surveyed companies indicate that innovation studies are carried out by only 12.9% of SMEs, compared to 31.3% of large companies. SMEs often have to address barriers limiting the potential for innovation (https://www.atn.edu.au/…).

The most common problems that restrict innovation are lack of funding, lack of product substitutes, insufficiently trained staff, limited knowledge of advanced technology and the scope of innovation, and a lack of skills and codification of knowledge. An effective strategy used in Austrian innovation experience is specialization to enhance production quality. However, research still has too little interaction with science to stimulate more advanced innovation; that is, products that are new on the market and are not only imitations or modifications of existing products. Of course, there are differences among SMEs in this regard. The technological level of the company is one of the most decisive characteristics indicating the potential and ability to innovate.

An important reason for the lack of initiative for innovation outside the sector of the company's operation is the small number of employees who would be able to work together in the process of network innovation. Large companies have better cooperation in the field of innovation than SMEs. Small companies should therefore focus on establishing external relationships to offset the lack of appropriate partners for cooperation in innovation within the region. Construction of an innovation network can also be made difficult by lengthy procedures for innovation implementation. The involvement of a distant network of partners is important for the creation of an innovative environment (Czaja, and Becla, 2013, p. 19-21; Peschl, Markus, and Fundneider, 2014, p. 347-350; Czakon, 2012, p. 99-101).

The most frequently indicated barrier to innovation is the financial barrier – lack of sufficient resources for innovation and too high a risk, for SMEs and large companies alike. Another barrier is properly qualified personnel, as well as its number. In daily operation, enterprises often lack time to implement the innovation strategy. This type of problem occurs more often among SMEs, where there may be no research and development department responsible for the initiation and implementation of innovation. However, the availability of technical knowledge or technology seems to be less important. Problems and barriers to innovation differ depending on the nature of the SME. The resources needed for the implementation of innovation are also important, particularly in the context of financial constraints. Low salaries for employees engaged in innovative research or processes do not encourage employees to take this type of initiative (Leoński, 2014, p. 233).

The dominant role of the entrepreneur or small business owner can lead to a narrow strategic perspective, particularly when he has no formal training or qualification in the field of innovation. Poor strategy and organization are weaknesses of SMEs limiting innovation. The focus of many SMEs on a small database of their clients does not develop their potential for innovation and may be a significant risk to the operation and opportunities for further development. Negligence and lack of a systematic search for new market opportunities complicate identification of the type of innovations an SME may wish to undertake. This is related to the fact that research in the field of innovation is rarely carried out in Austria (Piekut, 2013, 39-40).

Company activities can also represent problems for innovation within Austrian enterprises. In this context, SMEs, in particular, are adversely affected as it is harder for them than for large companies to adapt to new concepts and ideas and, by extension, innovation and innovative initiatives. SMEs find it easier to move in familiar environments with little growth potential than to take the risks associated with innovation, especially as the result of the innovation is often a great unknown and may not yield the anticipated results.

6. Summary

Austria and Poland have been intertwined for centuries, not least in the business arena. Austrian companies actively participate in the Polish economy and create many jobs on the Polish market. The tasks imposed on both countries in the implementation of the Europe 2020 strategy target the transfer of knowledge, protection of the environment and sustainable development. In this regard, both countries are moving in the direction of innovation, especially concerning nature protection, efficient production and respect for natural resources.

Accession to the European Union has had a positive influence on the dynamics and structure of trade between Poland and Austria. Austrian companies cooperate in investment in the hospitality industry, real estate and the production of construction materials. The industrial market is widely connected between the two countries, although to a lesser extent in innovation or via direct cooperation between Austrian and Polish companies.

Innovation, regardless of its form or country of origin, has always been a way to fight competition, especially for production companies. It seems that the fundamental problem behind the lack of innovation is the paucity of resources allocated for these purposes. Poland and Austria lack a common policy in cooperation in innovative projects. Other barriers limiting the cooperation in innovation are the lack of knowledge, lack of product substitutes and under-qualified staff, as well as the lack of skills and codification of knowledge.

Austria bases its action strategy on quality, while Poland focuses on cost strategies. Large companies are more likely to take innovative measures than SMEs. Therefore, from the point of view of innovative actions' effectiveness, the exchange of information and cooperation becomes necessary in the area of research and development, which may be carried out jointly by Polish and Austrian companies.

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BIODEGRADABLE WASTE MANAGEMENT AS A PRACTICAL EXAMPLE OF GREEN ECONOMY

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Abstract: In 2015, 10,863 thousand tonnes of municipal solid waste were produced in Poland. It is estimated that approx. 50% of this volume consists of biodegradable waste. Due to its properties, such waste degrades swiftly and poses a threat and a burden to the environment. System solutions regarding the collection and management of biodegradable waste constitute an example of sustainable development and green economy owing to the development of green products, services, public procurement, investments, and jobs. The objective of the present paper is to analyse biodegradable waste management in light of green economy and the idea of sustainable development. Research method encompasses the analysis of literature and statistical data in relation to biodegradable waste management both in Poland and Lublin Province.

Keywords: sustainable development, green economy, biodegradable waste, recycling.

1. The idea of sustainable development and green economy

The turn of the 20th century stimulated social sciences, especially economics, to reflect upon the expansive character of economic growth, which usually focuses upon maximisation of production, and ignores uncontrolled consumption of resources. The awareness of the limited character and deficit of natural resources resulted in anxiety regarding the growing burden on natural environment. In 1987, the World Commission on Environment and Development, also known as the Brundtland Commission, which was developed under the auspices of the UN, published a report entitled "Our Common Future". The report introduced the term sustainable development into public space and economic studies. The document highlighted the idea of population continuity and defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Raport…, 1987, p. 41).

The idea of sustainable development emerged as an answer to a broad spectrum of threats encompassing not only the degradation of environment, but also high demographic growth, inability to satisfy fundamental needs of a growing number of people, which resulted in the destabilisation of socio-economic systems. Therefore, the coexistence of three fundamental elements: economy, societies, and environment, was highlighted. Their effective coexistence is possible only in case limited resources are consumed reasonably (Szyja, 2015). The limited ability of the global ecosystem to renew its resources, along with the fundamental needs of societies, necessitate the application of a rolling costs analysis. As a consequence, one of the definitions of sustainable development determines that it is "the pursuit of ensuring all present and future generations access to sufficiently high ecological, economic, and socio-cultural standards regarding environment protection by the application of intra- and intergenerational equity" (Rogall, 2010).

Unfortunately, even though the implementation of sustainable development has become vital and constitutes a token of responsibility for future generations, its materialisation has only been declarative in character. The difficulty in dissemination of the idea results from both low awareness among populations, and lack of sufficient global involvement of individual states and businesses. Such globalism seems to be the key aspect of the issue. It results in the emergence of practical problems in the application of the concept at a local level e.g. in communes (Godlewska, 2014). As a consequence, the idea of green economy seems to be a more pragmatic approach to the matter (Burchard-Dziubińska, 2014). The term appeared in the report titled "Blueprint for a green economy" commissioned by the British government in 1989, and popularised in 2008 by the United Nations Environment Programme (UNEP). Green economy serves to improve human well-being, social equity, and decrease threats to the natural environment and ecological shortages. The following constitute its elements (Szyja, 2015):

- green products and services – those meeting specific environmental standards, thus non-invasive to the environment,
- green investments – efficient or sustainable in terms of energy and resources,
- green sectors of economy – environment-friendly technologies, renewable energy, etc.,
- green public procurement – directing public procurement towards the purchase of goods and services with limited impact upon the natural environment,
- green jobs – jobs contributing to restricting the consumption of natural resources, reduction of greenhouse gases and limiting the amount of waste and pollution.

Green economy does not replace sustainable development. By emphasising three elements: resource efficiency, low emission, and social inclusion, it makes the concept more concrete and practical. It is also believed that green economy is not a goal itself, but a tool enabling sustainable development to be achieved (Ryszawska, 2013). It can be said that it is an answer to the weakness of sustainable development, i.e. the lack of operationability and particular objectives along with means they can be achieved in. In case of green economy, particular emphasis is placed upon a shift of investments (both public and private), along with political

actions supporting these, towards actions limiting emission, improving energy and resource efficiency, but also those preventing the loss of biodiversity of ecosystems. The increase of income and employment, along with the decrease of poverty, are to be achieved by such means.

2. Biodegradable waste management as an element of green economy

The general understanding of the idea of green sectors of economy is usually narrowed down to actions associated with the production of renewable energy. Meanwhile, due to the fundamental role of the natural environment in the idea of green economy and sustainable development, the sector of environment protection, especially waste management, plays a critical role as well.

Waste, due to its quantity, physical, and chemical properties, constitutes one of the most considerable threats to the environment. Due to its accumulation, chemical cycling is altered, agricultural and forest areas diminished, soil and waters polluted microbiologically, and gases emitted into the atmosphere (Łabuz, and Łabuz, 2005). Biodegradable waste is significant in this respect. Due to its physical and chemical properties, it degrades swiftly and poses epidemiological threats and burdens to environment.

The Council's directive 1999/31/EC on the landfill of waste defines biodegradable waste as any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and cardboard (Dyrektywa Rady 1999…). Figure 1 presents a detailed classification of waste.
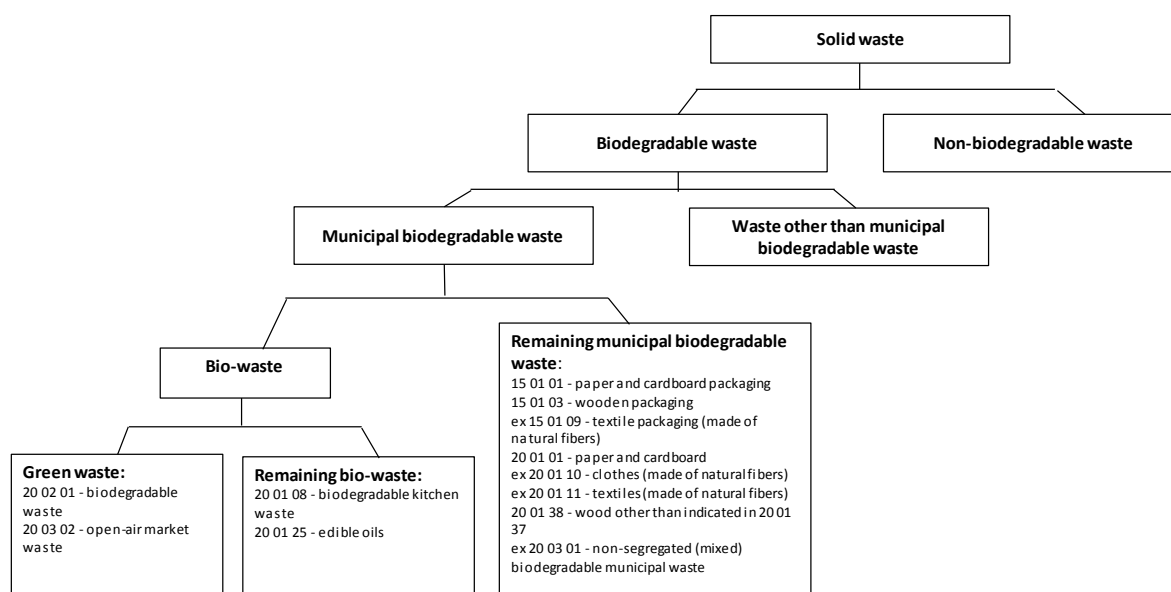

Figure 1. Classification of biodegradable waste. Note. Own study.

Biodegradable waste attracts particular interest of the EU with regard to sustainable development. However, actions aiming at restricting its negative impact upon the ecosystem were taken much earlier. The directive 75/442/EEC adopted in July 1975 declared that "member states shall take the necessary measures to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment, and in particular: without risk to water, air or soil, or to plants or animals" (Dyrektywa Rady 75…). Such declarations materialised with the publication of the Council's directive 1999/31/EC on the landfill of waste in April 1999.

The fact that even though landfill constitutes the oldest and most practiced waste management method, it is the least harmful to the environment, ought to be stressed. It is mainly due to the presence of organic substances which undergo physical, chemical, and biological processes associated with methane and CO_2 emission. It is estimated that methane originating from landfills constitutes 3-4% of the annual greenhouse gas emission. At the same time, methane absorbs infrared radiation 60 times more than CO_2, which has been popularised in media as the cause of the greenhouse effect" (Klimek et al., 2010).

Therefore, the fact that the directive obliges member states to develop national strategies aiming to decrease the quantity of biodegradable waste to be stored, does not come as a surprise. Actions were to be taken in order to reduce the quantity in consecutive years to strictly defined levels in relation to the base year 1995 (Dyrektywa Rady 1999…). In parallel, the waste directive of 2008 introduces regulations obliging member states to collect bio-waste selectively in order to ensure its subsequent recycling (Dyrektywa Parlamentu…).

Actions taken in the framework of green economy constitute an alternative to landfill storage of biodegradable waste:

- green services in terms of selective collection of biodegradable waste,
- green public procurement regarding collection and management of waste encompassing the treatment of waste ensuring ecosystem's protection,
- green investments generating green jobs in biodegradable waste processing installations, e.g. those composting or methanising selectively collected green waste, or mechanical and biological installations processing mixed solid municipal waste,
- green products in the form of composts (fertilizers and soil-improving agents) originating from selectively collected green waste, and heat and electricity obtained in methanisation of biodegradable waste.

3. Collection and management of biodegradable waste in Poland

In 2015, 10,863 thousand tonnes of municipal solid waste were produced in Poland. This means that each resident contributed to creating 283 kgs of solid waste (Założenia…). When compared with other EU states, the number is insignificant. In 2014 a statistical Pole created 268 kgs of waste, which ranked the country last but one among EU neighbours (see Figure 2). In addition, the 268 kgs constituted merely 56.42% of the total quantity of waste created by an average resident of the Community. To some extent, it is a result of differences in the economic development of Poland and "old EU members". The scale of the discrepancy seems to suggest that it stems from incorrect reporting, lack of system solutions regarding its verification, and primarily, a result of purposeful understatement of the quantity of waste by businesses (den Boer, 2013) (non-registered waste disposal at illegal landfills in order to reduce disposal costs).
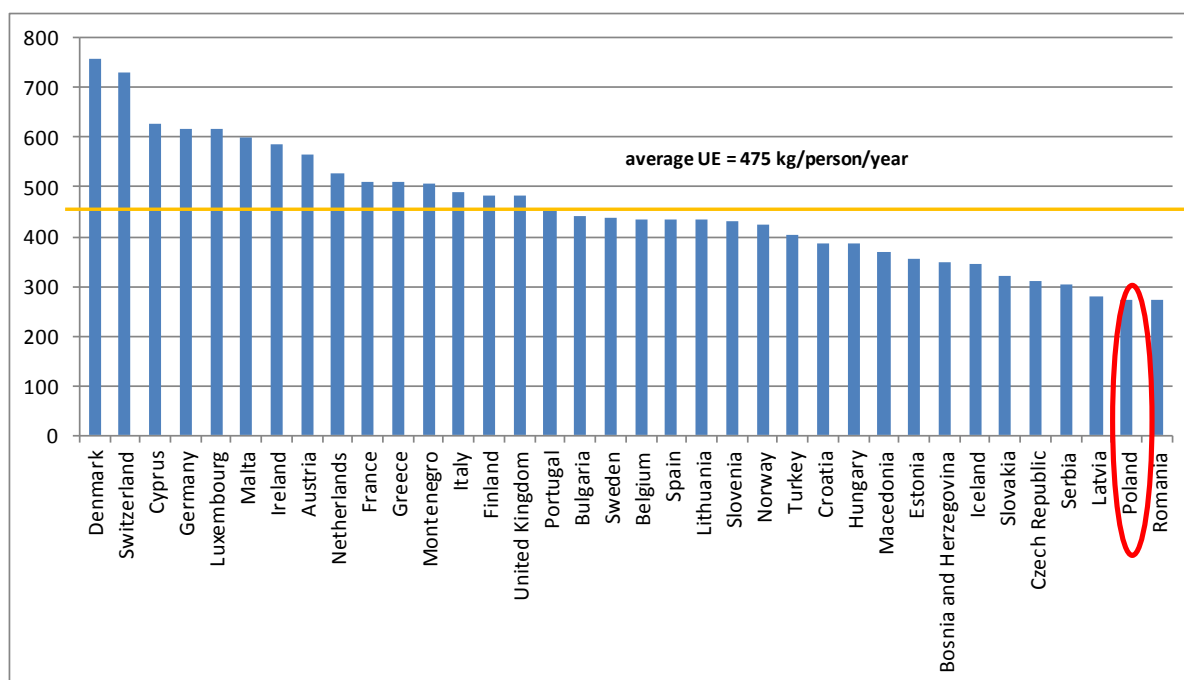

Figure 2. The quantity of municipal waste per resident in 2014 [kg/person/year]. Note. Own study on the basis of EUROSTAT (Municipal Waste Statistic).

In light of the above, an attempt at establishing both the quantity of municipal solid waste produced in Poland and the total quantity of such waste is fraught with the same risk. Due to the lack of a common selective waste collection system (except green waste), the majority is collected in the form of mixed municipal waste. When assessing its share in non-segregated waste, we are forced to follow the morphology of the waste, which, unfortunately, has not been systematised in Poland. As a consequence, assuming a 50.96% (Jędrczak, 2010) share of

biodegradable waste in municipal waste, approx. 5,536 thousand tonnes of organic waste are produced in Poland per annum.

Due to communes being granted the so-called ownership of waste, it was these organisations which were burdened with preparations towards the so-called garbage revolution (Założenia…) and its implementation. The commune organises waste collection and management in their respective areas. In addition, it is responsible for meeting waste management objectives, especially those regarding limits for biodegradable waste storage being met.

The authors of the new system of municipal waste management developed mechanisms embedded in the structure which are to facilitate the realisation of these new obligations:

1. regions of municipal waste management were introduced. Such a region may be composed of neighbouring communes with a total population of at least 150 thousand residents, or a commune with a population above 500 thousand (Ustawa o odpadach…, art. 35, ust. 5);

2. the division into individual regions of municipal waste management along with the establishment of regional installations is determined in provincial waste management plans (Ustawa o odpadach…, art. 35, ust. 4);

3. Regional Municipal Waste Treatment Plants (Regionalne Instalacje Przetwarzania Odpadów Komunalnych (RIPOK)) were defined as operating as waste treatment plants with the capacity to process waste originating from the region with a population of at least 120 thousand, and which meet state-of-the-art criteria, especially those applying to novel waste treatment technologies, or ensuring (Ustawa o odpadach…, art. 35, ust. 6);

   a) mechanical and biological treatment of mixed municipal waste;

   b) selective treatment of collected green and other bio-waste, and recycling it into products of fertilizing or crop-yielding character;

   c) storage of waste originating from mechanical and biological treatment of mixed municipal waste and post-sorting-municipal-waste remains;

4. transregional municipal waste treatment plants were defined as those operating as incineration plants with the capacity of processing municipal waste collected in a region with a population of at least 500 thousand, and meeting state-of-the-art criteria (Ustawa o odpadach…, art. 35, ust. 6a);

5. a ban on collecting mixed municipal waste and green waste outside the area they were produced in. Therefore, such waste needs to be processed in indicated regional plants. The ban excludes reloading stations and municipal waste selective collection stations (Ustawa o odpadach…, art. 23, ust. 2, 10, 11);

6. a ban on collecting mixed municipal waste and green waste outside the region (Ustawa o odpadach…, art. 23, ust. 3);

7. a ban on processing mixed municipal waste, green waste, and post-sorting-municipal-waste and mechanical and biological processing remains to be stored, outside the region

(Ustawa o odpadach…, art. 20, ust. 7) – this excludes mixed waste to be incinerated in transregional plants (Ustawa o odpadach…, art. 20, ust. 10);

8. obligation to direct green and mixed waste directly to regional plants, and obligation for managers of selective collection stations to direct green waste directly to regional plants (Ustawa o utrzymaniu…, art. 9e, ust. 1, pkt. 2; Ustawa o utrzymaniu…, art. 9ea, ust. 2);

9. obligation for communes to establish the selective collection station with easy access for all residents of the commune and one which would ensure the collection of selectively collected green waste (Ustawa o utrzymaniu…, art. 3, ust. 2, pkt. 6; Ustawa o utrzymaniu…, art. 3, ust. 2a);

10. obligation for communes to establish selective collection of municipal waste in their areas, which would encompass biodegradable municipal waste, among others (Ustawa o utrzymaniu…, art. 3, ust. 2, pkt. 5).

The system was supplemented with "sealing" regulations introduced by the Minister of Economy in the regulation on the admission of waste to be stored (Rozporządzenia…). The ban on storing mixed municipal waste in landfills was enforced on 23rd January 2015. As a consequence, attempts at managing waste by bypassing regional plants were curbed.

After three and a half years the new municipal waste management system has been in operation, conclusions on its efficiency for biodegradable waste management may be drawn. Primarily, an increase of selectively collected biodegradable waste ought to be noted (see Table 3). In 2013, which inaugurated the operation of the system, a 54.63% growth in the quantity of the waste was observed. The phenomenon was seen as a consequence of easy access to bags and containers. In the consecutive year, the quantity of collected biodegradable waste grew by 87.20%. It proved the evolution of the system but also the quantity of such waste which had not been previously registered. In 2015, the growing trend continued (even though the scale was crippled by climatic factors impacting vegetation – approx. 12% decline in precipitation). The fact that only 53% of local governments collected biodegradable waste from their residents in that year is noteworthy (Wierzbowska-Kujda). In the majority of communes, biodegradable waste was collected via the selective waste collection stations. However, the fact that such collection is limited to selective collection of green waste is noteworthy.

Table 1.
Selective biodegradable waste collected in 2007-2015

Specification	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total municipal waste [thousand Mg]	10,082.6	10,036.4	10,053.5	10,040.1	9,827.6	9,580.9	9,473.8	10, 330.4	10, 863.5
Selectively collected biodegradable waste [thousand Mg]	85.2	123.1	164.2	181.3	210.0	201.6	311.8	583.7	657.1

Annual growth of the quantity of biodegradable waste [%]	-	44.57%	33.31%	10.45%	15.85%	-4.00%	54,63%	87.20%	12.57%
Share of selectively collected biodegradable waste in municipal waste	0.84%	1.23%	1.63%	1.81%	2.14%	2.10%	3.29%	5.65%	6.05%

Note. Own study on the basis of data from the Central Statistical Office of Poland.

Similar conclusions can be reached when analysing data concerning selective collection of green waste in three sectors of Lublin between July 2013 and November 2016, i.e. after the garbage revolution was implemented. The data is compiled in Table 4. 2014 witnessed a significant growth of the collected waste (46.04% between July and December in relation to respective months in 2013). In 2015, the situation stabilised (11.10% when compared with 2014). The data covering 2016 indicate a surprising and considerable growth in the quantity of the collected green waste (18.79% when compared with 2015). The phenomenon ought to be considered as the outcome of the system's learning.

Table 2.
Quantity of green waste selectively collected between July 2013 and December 2016 in three sectors of Lublin

Year	Quantity of green waste selectively collected in individual months [Mg]												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
2013							148.9	156.4	166.6	431.0	468.2	55.9	1,426.9
2014	0.0	0.0	0.0	276.6	268.1	255.3	284.8	241.9	276.5	482.4	609.5	188.9	2,883.8
2015	56.1	45.5	127.4	221.1	320.8	323.6	230.4	137.9	213.3	339.5	860.0	328.5	3,204.0
2016	13.2	41.4	137.1	315.2	378.3	369.1	317.4	371.5	316.4	462.0	918.4	166.1	3,806.1

Note. own study on the basis of data from KOM-EKO S.A.
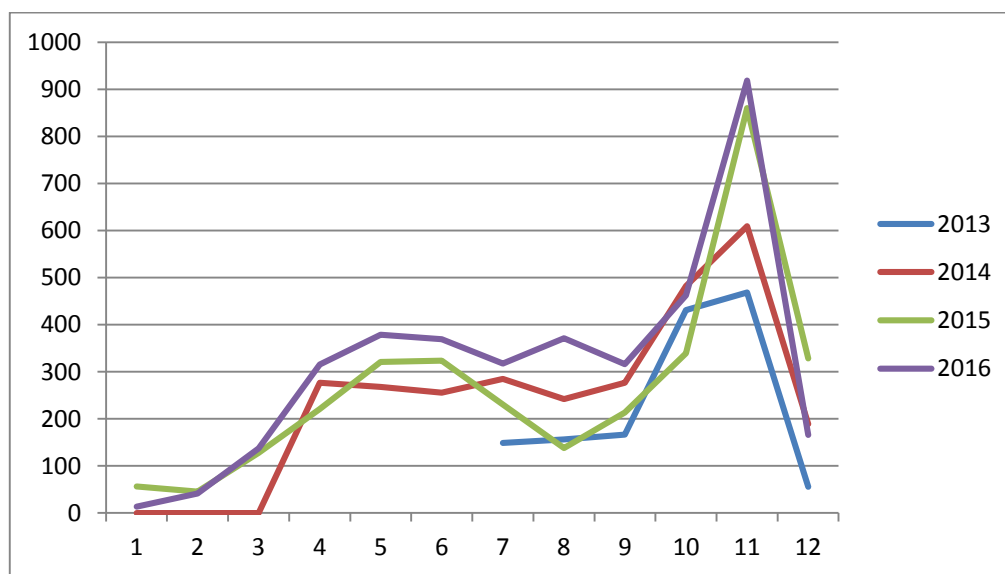

Figure 3. Seasonal changes in selective collection of green waste between July 2013 and November 2016 in three selected sectors of Lublin. Note. Own study.

The increase in the selective collection of biodegradable waste resulted in the increase of the waste being biologically treated (see table 5). In 2015, 1,750 thousand tonnes of waste were composted or fermented, which constitutes a 55% growth when compared with 2012 – the year preceding the introduction of new systemic solutions. At the same time, the share of anaerobic and aerobic waste management among all means of waste treatment in Poland increased in the respective period from 11.77% to 16.11%. In accordance with the 2022 National Waste Management Plan, such processes were conducted in (valid for 31.12.201.):

- 97 plants for treatment of selectively collected biodegradable waste with the total processing capacity of 873,213 Mg per annum;
- 127 mechanical and biological plants for treatment of mixed municipal waste with the total nominal biological processing capacity of 4,100,017 Mg.

Table 3.
Methods of municipal waste processing methods applied in Poland between 2011 and 2015 [in thousands of tonnes]

Waste processing methods	2011		2012		2013		2014		2015	
Recycling	1,119	11.39%	1244	12.98%	1499	15.82%	2180	21.10%	2867	26.39%
Composting or fermenting	1.644	16.73%	1128	11.77%	1230	12.98%	1154	11.17%	1750	16.11%
Thermal processing	98	1.00%	51	0.53%	766	8.09%	1560	15.10%	1439	13.25%
Storage	6.967	70.89%	7158	74.71%	5979	63.11%	5437	52.63%	4808	44.26%
Total collected waste	**9,828**	**100 %**	**9,581**	**100 %**	**9,474**	**100 %**	**10,331**	**100%**	**10,864**	**100 %**

Note. Own study on the basis of data from the Central Statistical Office of Poland.

Therefore, the assessment of the system's efficiency regarding the reduction in the quantity of biodegradable waste to be stored seems valid. On the basis of the 2022 National Waste Management Plan, it can be observed that in 2013, Poland reduced the quantity of biodegradable waste by 40%. In 2014, the result was even better, and the reduction amounted to 35%. In both cases, the reduction mandated by regulations was achieved. In addition, in 2014, the reduction foreseen to be met on 16th July 2020 was met.

The data compiled in Table 6 indicate even higher results. It was at the onset of the system's operation that the result foreseen for 2020 was achieved. Results regarding regional outcomes are more diversified – in 2013-2014, one in nine regions did not meet the mandated reduction.

Table 4.
Reduction of biodegradable waste quantity achieved in Lublin Province between 2012 and 2015

Region	2012	2013	2014	2015
Biała Podlaska	28.50	30.10	20.23	8.86
East-Central	50.20	39.,80	30.21	28.74
Central	52.40	44.60	12.59	19.19

Chełm	24.90	12.00	16.63	13.48
South-Western	42.60	26.70	21.39	23.47
Southern	27.40	34.50	28.46	30.47
North-Western	31.90	27.20	28,91	23.50
Puławy	60.70	33.60	31.99	29.70
Zamość	53.10	55.20	63.19	8.24
Lublin Province	*40.20*	*32.20*	*28,30*	*20.63*
Required level	75.00	50.00	50.00	50.00

Note. Own study.

Even though such surprisingly good results stem from the composition of the indicator determining the level of reduction, with the present saturation of regions with biodegradable waste processing plants, Poland's meeting the mandated requirements remains uncompromised. Although stabilising processes conducted in mechanical and biological mixed municipal waste treatment plants offer the greatest contribution to outcomes, the fact that constant improvement of selectively collected biodegradable waste management ought to be a necessity, must be highlighted. The declared processing capabilities of national plants exceed the nominal quantity of waste collected in 2015 by 32.87%. However, individual provinces and regions suffer a deficit of free processing capabilities.

In light of the requirements placed by EU pertaining to circular economy, a question if such results are satisfactory, arises. The postulated 10% limit on municipal waste storage to be achieved in 2030 seems concerning. The fact that in 2015, 44.26% of municipal waste was stored in landfills ought to be kept in mind. This has been the most effective result in history. However, it is far from the objective to be achieved in the perspective of merely 14 years. The rate of reduction may be misleading- over the past 5 years, the share of stored waste decreased by 5.33% per annum. The rate resulted from the development of processing plants (238 plants with the total processing capacity of 3,334.6 thousand Mg in 2010, and 340 plants with the total capacity of 13,129.9 thousand Mg in 2014). In subsequent years, a decline will surely be observed. Therefore, the achievement of the reduction foreseen for 2030 will be impossible without changes in collection and treatment methods. When the fact that mixed waste constitutes the dominant fraction in municipal waste (76.64% in 2015), and the fact that biodegradable waste in the form of kitchen waste constitutes the majority of mixed waste, is considered, it seems that the development of selective collection of such waste seems to be the target solution. Such an approach will facilitate the effective biological treatment of such waste in order for fertilising agents to be produced instead of stabilising biodegradable fractions in mechanical and biological processes and storing these (at least 35% of mixed municipal waste is mechanically and biologically processed and then stored). The first step has been made in the regulation of the Minister of Environment on detailed means of selective collection of selected fractions, which introduced the obligatory container for biodegradable waste (Rozporządzenie…).

The development of biodegradable waste selective collection seems to be a significant tool in achieving the second objective of the circular economy, i.e. 60% of municipal waste to be

recycled in 2025 and 65% in 2030 (Komunikat…, 2015). According to the 2022 National Waste Management Plan, the following recycling levels were achieved: 22% in 2013, and 26% in 2014. In light of these figures, the level of 50% mandated in 2020 and 70% postulated for 2030, seem challenging and difficult to materialise. On the one hand, segregation and selective collection of biodegradable waste will improve the quality and efficiency of recycling packaging waste. On the other hand, this will increase the volume of organic waste which may be recycled. It requires a system of selective collection of kitchen waste to be developed and a network of plants processing such waste into fertilising agents to be improved.

4. Conclusions

To conclude, when reviewing the state of biodegradable waste management in Poland, the following ought to be considered:

- municipal waste management, especially the biodegradables, which constitutes an element of green economy, forms a vital element of actions aiming to implement the idea of sustainable development;
- biodegradable waste attracts particular attention of the European Commission due to the fact that methane created in decomposition processes in landfills constitutes 3-4% of annual greenhouse gas emission;
- the new system of waste management implemented in Poland in 2013 generates green products and services, green public procurement, green investments and jobs;
- the implementation of the new system of waste management based upon common and ready access of residents to the collection of municipal waste resulted in the growth of the quantity of selectively collected green waste. In 2015, the collection of green waste was three times higher than in the base 2012 which preceded the implementation of the system. The tendency is constant;
- the share of selectively collected green waste in the total quantity of collected municipal waste increased from 2.10% in 2012 to 6.05% in 2015 despite the fact that organised waste collection was conducted by only 53% of communes;
- the share of biological waste treatment processes in plants in Poland was higher in 2015 when compared with the base 2012 by 4.33%. At the same time, the share of waste stored was lower by 30.45%;
- the development of regional municipal waste treatment plants ought to be considered as an element of green investments and green jobs creation, and was reinforced by the ban on mixed municipal waste storage. With regards to the present calculation methodology, it ensures Poland meets the EU quota of reducing storage of biodegradable waste – the quota required in 2020 was met in 2014;

- Poland's meeting EU regulations regarding the idea of circular economy in 2030, both in case of municipal waste recycling (65%) and the reduction of the quantity of waste stored (10%), will be impossible without the intensification of selective biodegradable waste collection (especially kitchen waste) and development of a network of plants organically recycling such waste. Biological processing modules of mechanical and biological plants seem to be applicable in such cases. Such actions ought to result in the increase of biodegradable waste being recycled and the emergence of a synergy effect regarding quality improvement and a boost of packaging recycling.

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