Adaptive model of sustainable business development against the example of the Conurbation of Upper Silesia and Dąbrowa Basin

G. Sierpiński, I. Celiński and M. Staniek

***Abstract*—** The 3P (Profit, People, Planet) model is one of basic tools of sustainable business development where three equivalent aspects, namely economic, social and environmental ones, are taken into account. Most frequently, the attention of persons in charge of business development is mainly focused on the economic aspects of operations. However, the authors claim that people related to the business comprise an equally significant sphere of its activity, and the only one which may be considered subject-oriented. Bearing such a perspective in mind, this article provides a proposal of an adaptive model of sustainable business development targeting the economic activity subject, analysed from the angle of networks being most important for the latter, namely the transport and the settlement network. The authors have discussed a dynamic method of assessing the degree of matching (adaptation) between businesses and various networks, such as the aforementioned settlement and transport network as well as others. Dynamic adaptation is of key importance on account of the human factor of business activity which may be dynamically allocated against diversified contexts, the most important ones being the transport and the settlement network context, followed by other prioritised systems, i.e. economy, culture and entertainment, education etc. The transport network is the main factor for effectively delivering sustainability of business development. Adaptation to this network is decisive of other aspects of sustainable business and its functioning, mainly the economic and the personal, but also the environmental ones. In light of all the aforementioned networks, the matching (adaptation) of a business, according to its specificity, allows it to attain satisfactory economic profit and other benefits conforming with expectations of the local community and principles of environmental protection. Through adaptation to requirements of the said systems, businesses also pursue the personalistic concept of economic theory.

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I. Introduction

WITH regard to symmetry in the man-economy-natural environment system, far more emphasis should be laid on the subject-oriented nature of sustainable business development. In the article, authors have proposed their own modified version of a model referred to as 3P (Profit, People, Planet) [1]-[3]. The authors' model entails the fact that every business constitutes an inextricably linked fraction of what surrounds it. The shared element of the business environment is the transport network, along with all its constraints. Goals of every economic activity should be focused on the determinants considered relevant from the perspective of its operations, resulting from the very fact that other systems exist in the surrounding. When considering economic and environmental aspects of business activity, one should take an extensive array of computational methods and procedures into account [4], [5]. The pursuit of economic objectives defined by every business is subject to rational assessment consisting in measurement of the company's goodwill and profitability of the chosen growth model ([1], [6]-[10]). The environmental impact of business activity is subject to assessment based on individual technical solutions measured according to specific pre-defined indicators of pollution or emission. As opposed to the pollution measurement, methods for assessment of business adaptation to a social system (or to put it more broadly, people and the way they use the transport network) are not equally unambiguous and easily measurable. This impact may be measured in a narrow scope ([11], [12]). Methods ensuring adaptation of businesses to the transport network have also not been widely discussed in the literature.

What matters particularly for sustainable business development is appropriate management of human capital ([12]-[17]). According to the authors, the activities undertaken in the areas of knowledge management in an organisation, employee assessment, outplacement, incentive systems or personnel potential analysis are not appropriately conducted in the context of internal business structure only, i.e. without

analysing the external environment, including the transport network [12], [16]-[20], i.e. another element of major impact, affecting both the business and the related people ([21]-[27]). What affects sustainable development of business besides the transport network is the settlement network or the networks of education, health care, sports and recreation, etc. The transport network is a motor of the synergy driving the relationships between the aforementioned networks and the business ([24]-[28]).

In this article, the authors have proposed a specific approach to sustainable business development which entails the principles and directions of development mentioned in [29]-[31]. Special attention has been paid to the relationships between individual systems with reference to creation (by way of synergy) of a sustainable business development-friendly environment. The role of the human factor in business is determined by parameters of the transport network. According to this approach, the accent is shifted from an internal business viewpoint towards observation of the business exterior from a holistic perspective entailing all aspects of business operations, where the "medium" is the people. Two factors are of particular importance in this respect: the human and the environmental one. These two factors, on the other hand, create the model of ethical entrepreneurship (Jabłoński [1], Piontek [3]). The concept of sustainable business development proposed in the article is based on application of institutional and non-institutional sources of information which may have impact on the development of a sustainable business.

The authors of this article have proposed a model to define the way in which one should dynamically create and develop nearly any chosen business from the perspective of changes taking place in its environment, in time and space, based on an analysis of generally available institutional data. It should be noted that, while applying this model in a dynamic context, one can manage the business development in a manner depending on the changes occurring in the transport and the settlement network. The dynamism of changes taking place in the business environment is growing year by year, which stems from the dynamism of changes in the society itself. In the third section, the model proposed for the business adaptation to the external environment has been described from the angle of sustainable development. Section four provides a description of the source of data used in the model. The model is conventionally referred to as "business-to-environment matching assessment" (BEMA).

II. State of the Art

THE need for sustainable business development stems from the fact that, as provided in the 2012 Living Planet report, the contemporary humanity is using the equivalent of 1.5 of the planet's available resources (i.e. exceeding the limit of available resources) [32]. Unfavourable forecasts of increasing consumption on Earth have also been provided in some other reports (Randres [33]). Undoubtedly, this requires that energy and material consumption is reduced in production of goods and delivery of services, but also imposes the necessity of relying on the planet's renewable resources more and more extensively. Sustainable business is a project characterised by minimum negative impact on local communities, natural environment and economy [34]-[36]. The foregoing definition lays an emphasis on the impact aspects, which does not necessarily translate into the sustainable business development per se.

Models of sustainable business development (SBM models) stress different ways of achieving the aforementioned goals, however, they should all meet certain basic criteria. First and foremost, they should take environmental aspects into consideration in a broader manner compared to businesses based on what may be referred to as a traditional approach (operations focused on economic performance exclusively). The sustainable approach should deliver environment-friendly products and services, which does not merely mean that every aspect of business operations should entail sustainable development. Business should rely on well-balanced proportions of measures of its activity: economic, human and environmental. The most popular document to have formulated principles of sustainable development is the Brundtland Report [37]. Sustainable business development is a matter of appropriate balance between different indicators characterising the business. Tueth's paper [38] mentions basic properties of sustainable development, the most important of which is the equal status of three most significant components of a sustainable business: employees, natural environment and financial measures of its activity (which referred to as the triple top line value principle). Further factors conditioning sustainable development include utilisation of natural and renewable energy sources by business divisions (balance of resources), emulation of natural principles and systems functioning in the nature, making the most of local economic conditions on the way towards sustainable business development, supporting local businesses and public utility institutions (local balance). Recycling should be the most basic origin of the resources acquired by a business which pursues sustainability of its development. Equally significant is the fact that the process of business development by making it sustainable should be continuous (dynamic). The foregoing description implies that there are many competitive methods of attaining sustainable business development. A combination of different sustainability approaches, as presented in paper [11], e.g. creating combined smart products (service + product) in connection with recycling, forms a set of possible models of sustainable business development. However, no directions chosen on the way towards business sustainability should considerably alter the proportions originally envisaged between the following three: people, economy and natural environment.

Among those which may be classified as sustainable business development models, one should mention the natural capitalism model [8] stressing the critical interdependence between production and utilisation of human capital combined

with sustaining the natural capital. The author of publication [8] claims that maintaining this critical relationship between the said systems has been the very reason why they still exist at all. Another one is the model of closed systems [7] based on the idea of Closed-Loop Supply Chains (CLSC). A commodity supplied to the customer is reworked multiple times. What this model stresses in particular is ecology and protection of natural environment. Without analysing the impact of quality of a reworked product on people (in terms of reliability, toxicity etc.), this model, as the authors claim, is incomplete. Another model of sustainable development is a social enterprise [6] conducting economic activity based on precisely pre-defined social goals. Enterprises of this kind invest their financial surpluses in local communities as well. This objective is pursued in such a manner that, instead of maximising shareholders' or owners' profit, i.e. profit of those who often come from outside local communities, the profit is allocated where it has been generated. A weakness of these models can be perceived in the fact that, whatever the goals pursued might be, including the local ones, they are still encumbered with particular interests of specific social groups. Another group of SBM models is referred to as product service systems (PSS) [38]. The approach in question may be brought down to offering a conglomerate of services and products instead of focusing on a single product only. By definition, such an approach ensures better adaptation to the needs of market recipients. This concept is implemented by offering smart products in the market (smart television sets, refrigerators etc.). According to the authors, this approach is not always beneficial for people, since it may to lead to creating monopoly for supply of specific high-tech products. An approach which may be considered interesting is known as Blue Economy [39]. The related models are focused on application of open-source scientific solutions for the sake of rational utilisation of social and environmental resources, and furthermore, as mentioned in paper [39], specific solutions are proposed to create new values (products and services) instead of reducing costs of those which already exist. This approach is pursued by creating new jobs, reducing energy consumption and upgrading production processes. The said model combines many noble concepts and ideas, and even so, its implementation should be more closely linked with economic conditions. For instance, fostering generally available (open-source) solutions always requires that abundant and usually external funding sources are involved in the initial stage of their development.

To recapitulate the above elaboration, it may be claimed that the following major shifts in the business activity model towards sustainable development are recognised in the literature of the subject [38], [6]-[9]: increasing environmental efficiency (lean, cleaner production, eco-design), implementing pro-social economy (blue economy, natural step, prosperity without growth), recycling-based creation of values (recycling, closed loop and industrial symbiosis), combining products and services into smart products, innovative activity, solutions based on creation of social enterprises

III. Methodology

The model of sustainable business development according to the approach proposed is built on the foundations of three main axes. The first one is the choice of innovative service which may be rendered by the given business in a specific market located within a specific area analysed, , this being the way to develop. The choice of the innovative service is not only determined by the provider's capabilities to deliver it, but primarily by the target market conditions (global and local stimulants and destimulants). Therefore, the choice of the service type and the manner of its implementation is determined by a set of parameters describing the given area (second axis of the sustainable business development analysis). The area of analysis may be described from the perspective of the service being introduced using variables characterising the "demand part" of the given service (these being the demand stimulants of business development). The set of these parameters is essentially independent of the set of parameters describing the "supply part" of the given service (supply stimulants of business development). Additionally, the possibility of using (combining) stimulants and minimising the impact exerted by destimulants in the delivery of the given service is implied by transport networks (third axis of analysis). Consequently, the sustainable business development model in question may be noted as follows:

$$U_i = f(S(t), F_i^D(t), F_i^S(t), F_i^{TN}(t), nd(t)) \quad (1)$$

where:

$S(t)$ – size of the area subject to analysis for which the business is planning to implement the given service, being variable in time as a consequence of different dynamic processes, e.g. suburbanisation,

$F_i^D(t)$ – demand stimulants for the given service; a set of parameters describing the given area in terms of characteristics favourable to the service provision to customers; for instance, for sales of smart toys, such a stimulant would be the distribution of the number of children living in the given area, and to a lesser extent, the distribution of inhabitants' income etc.

$F_i^S(t)$ – supply stimulants; a set of parameters describing the given area in terms of characteristics favourable to the service provision capabilities of the business; such a stimulant would be e.g. the scatter of the business's distribution points for the given service or the number of distribution channels etc.

$F_i^{TN}(t)$ – set of the transport network parameters; variables, most frequently indicators, which characterise sections of the transport network, e.g. indicators of density, traffic congestion, quality of traffic control systems.

$nd(t)$ – method for delimiting the area; a division of the network into uniform or non-uniform subareas, referred to as spatial territories (or, as in transport network modelling,

circulation territories).

On account of a non-uniform spatial and temporal distribution of parameters of type F_i in area S subject to analysis as well as its large surface dimensions, which can often be observed, it requires delimitation. The simplest form of delimitation is one which is based on the administrative division of the given area. In this respect, one can use the division typical of the EU, i.e. a division into units following the NUTS type statistical analysis, or – for increased precision – make use of local administrative arrangements (thus creating units smaller than in NUTS).

Thus the set of demand and supply parameters is established with reference to individual spatial territories defined within the area subject to analysis. The set of demand parameters (F_i^D) should be defined each time the business chooses the nature of an innovative service. This set should comprise characteristics describing the area analysed from the angle of variables favourable to provision of the given service type, i.e. demand stimulants:

$$F_i^D(t) = \{P_1(t), P_2(t), ,..., P_i(t), ..., P_n(t), \} \quad (2)$$

where:

$P_i(t)$ is the ith parameter (demand stimulant) of description of the area analysed, supporting the provision of the given service in terms of the demand for it, chosen from a set of n such parameters.

They are variables describing customer expectations within the given territory with regard to the service proposed and the facilities supporting its provision, but not on the business decision making side (i.e. under management of the business). For example, what one should take into account while selling electric cars is the spatial distribution of such factors as: inhabitants' income, number of recharging points, energy prices, fuel prices, level of environmental awareness, educational level etc. within the area subject to analysis. In this study, instead of searching for single stimulants, the authors have proposed that some general statistical characteristics of individual delimited systems should be applied with reference to spatial territories.

The set of supply parameters (F_i^S) should be defined each time the business decides about the specificity of an innovative service. This set should comprise characteristics describing the area analysed from the angle of variables favourable to provision of the given service type from the business's point of view (its potential, strategy etc.):

$$F_i^S(t) = \{P_1(t), P_2(t), ,..., P_j(t), ..., P_m(t), \} \quad (3)$$

where:

$P_j(t)$ is the jth parameter of description of the area analysed, supporting the provision of the given service in terms of its supply, chosen from a set of m such parameters.

They are variables describing the area analysed in terms of facilities or customer expectations, which only depend on the business itself (being those that the business can generate or stimulate). Referring to the example of sales of electric cars, they may be as follows: number of sales points, price discounts, recharge points allocated or financed by the manufacturer, distribution of the number of advertisement points financed by the manufacturer etc. Sets $P_i(t)$ and $P_j(t)$ of the parameters being crucial for the service provision are each time identified by the service provider (or manufacturer) based on their knowledge as well as a selection of publically available data described in the next article section.

The set of transport network parameters (F_i^{TN}) is described by variables defining the transport network in a scope being significant from the perspective of the capacity to provide the innovative service proposed by the business:

$$F_i^{TN}(t) = \{P_1(t), P_2(t), ,..., P_k(t), ..., P_o(t), \} \quad (4)$$

where:

$P_k(t)$ is the kth parameter of the transport network description, relevant from the perspective of the capacity to deliver the innovative service.

All parameters used in the above equations (1)-(4) are variable in time, which imposes the dynamic nature of the business sustainability model presented. The parameters occurring in equation (4) should, however, be correlated with the parameters identifying the demand and supply stimulants. Therefore, one must determine the degree to which, for instance, the transport network density affects the level of car sales and what is its impact on the sales of smart navigation devices.

Delimiting the area subject to analysis triggers a division of area S into s_d spatial territories, each being indexed in the scope of demand and supply stimulants, thus leading to data being acquired within every territory:

$$F_i^d(t) = \{P_1(t), P_2(t), ,..., P_l(t), ..., P_p(t), \} \quad (5)$$

where:

$F_i^d(t)$ – set of parameters describing the dth spatial territory in terms of implementation of the innovative service within its area (supply and demand stimulants),

$P_l(t)$ – lth parameter supporting the service provision (total population, number of inhabitants in the age of 12-15 years, number of schools, production capacity for the given spatial territory etc.).

Acquisition of the set of parameters describing both the capacity and the probability of succeeding in delivering the given service for each area analysed should be concluded by correlating these values. Part of the parameters thus obtained will diverge from others in terms of spatial distribution in individual territories included in the analysis, and therefore, they will not be relevant from the perspective of implementation of the innovative service. Individual

parameters of the description of spatial territories from the area subject to analysis are correlated in pairs in the following manner:

$$r_{s^* s^{**}} = \frac{\sum_{i=1}^{n}(p_i^* - \overline{p^*})(p_j^{**} - \overline{p^{**}})}{\sqrt{\sum_{i=1}^{n}(p_i^* - \overline{p^*})}\sqrt{\sum_{j=1}^{n}(p_i^{**} - \overline{p^{**}})}} \quad (6)$$

where:

p^*, p^{**} – consecutively correlated parameters describing the area analysed.

The correlation of parameters describing the area analysed enables elimination of parameters being irrelevant for the service rendered. Consequently, a new set of variables describing the area subject to analysis is created (F'_i). The parameters are correlated with reference to spatial territories defined in the area analysed. As a result of the analysis, such as the one described above, one obtains a set of spatial territories in which the best correlation ratios were acquired for individual analysis parameters chosen to function as stimulants for implementation of a specific innovative service:

$$\{s_d(\max \sum r_{s^* s^{**}})\} \in \{s_d\} \quad (7)$$

However, not all spatial territories included in (7) are favourable to implementation of an innovative service, which results from further limitations imposed by parameters of the transport network. Parameters of transport network $F_i^{TN}(t)$ are separately defined for every spatial territory based on such characteristics as the transport network density in the dth territory, a sum of traffic volumes, time of travelling through the dth territory, queues etc. The value of the selected transport network parameter for the dth territory either weakens or amplifies the effect of previously chosen stimulants. If the transport network parameters in the given territory are not sufficient to provide the given service, then the value of the stimulants observed in the same territory is irrelevant. The foregoing is established with reference to the obligatory correlation between parameters of the network in the given spatial territory and values of stimulants, or optionally, by application of spatial methods such as, for instance, local indicators of spatial association (LISA):

$$r^{GLOBAL} = \frac{\sum_{i=1}^{n}(f_i - \overline{f})(f_j^{TN} - \overline{f^{TN}})}{\sqrt{\sum_{i=1}^{n}(f_i - \overline{f^*})}\sqrt{\sum_{j=1}^{n}(f_j^{TN} - \overline{f^{TN}})}} \quad (8)$$

where:

r^{GLOBAL} – coefficient of matching between stimulants for the given service activity and transport network parameters,

f_i – sum of values of the autocorrelation coefficient obtained in the given spatial territory,

f^{TN} – values of the parameter describing the transport network in the given spatial territory.

In order to ensure sustainable business development, coefficients of the transport network description should be appropriately selected in a manner minimising the negative environmental impact of the service rendered. For that purpose, spatial territories characterised by high saturation of emission of harmful substances should be indexed in a manner ensuring that they can be eliminated from subsequent analysis as a consequence of the model's influence (the given indicator assuming zero values). An alternative approach may consist in choosing the coefficients of the network description in such a way that traffic can be successfully directed towards areas of high capacity to absorb pollution (maximum values of the network description coefficient).

On account of the fact that all the parameters occurring in equations (1)-(8) are variable in time, the process of attaining sustainability of business development should be reiterated within the pre-set interval of Δt. Such an approach to dynamic sustainable business development has been illustrated in Figure 1. Establishing the value of the said interval was not among the subjects studied and addressed in this article.

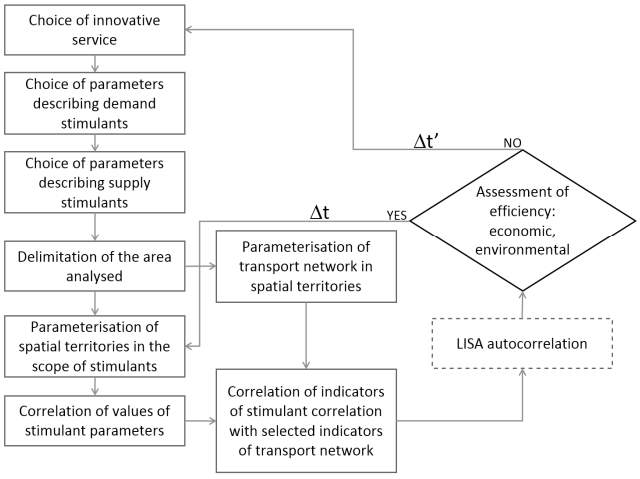

Fig. 1 Dynamic model of sustainable business development.

In such an iterative loop in which the sustainable business development functions, one can assess the economic and environmental performance of the business on a cyclic basis, and in the case of the changes observed among the economic or environmental parameters, the service may be altered or modified. Changes in terms of the location where the service is rendered will basically occur with a relatively small interval Δt, whereas changes to the service parameters or its complete withdrawal or substitution with another service – with interval $\Delta t'$.

Each time the location of business divisions offering a specific service is changed, one should bear in mind the minimisation of the transport network traffic (less intense traffic translates into lower emissions of pollutants, as shown in Figure 2) connected with the transport activity conducted in the course

of provision of the given service:

$$PP(l_1,l_2,...,l_s,....l_z) < PP(l_1,l_2,...,l_t,....l_{yz}) \quad (7)$$

where:

PP – transport activity connected with the service provision (converted into service units)

$\{l_1,l_2,...,l_s,....l_z\};\{l_1,l_2,...,l_t,....l_y\}$ – set of locations of the service distribution points in successive iteration steps.

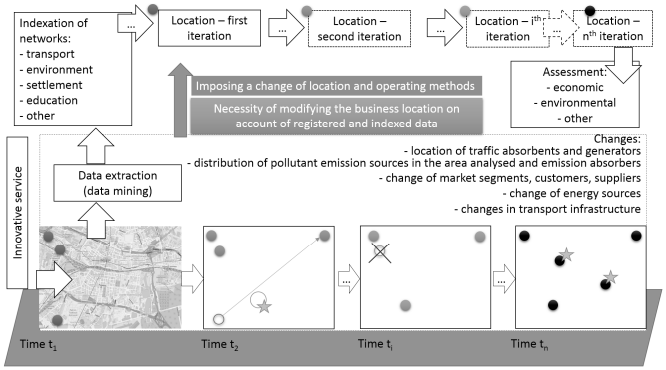

Fig. 2 Graphical representation of the sustainable business development model.

An assessment of the economic and environmental performance of the service provision imposes the necessity of relocating the service distribution points or changing the nature of the service itself. However, an analysis of this kind is not among the subjects addressed in this article.

IV. Acquisition of Data and Their Sources

WHAT sustainable business development requires besides the choice of a general action strategy (innovation, renewable energy sources, CLSC, PSP) is that it should be correctly placed in time and space. The number of variables which may be taken into consideration in such a process is practically unlimited. As regards the transport network, it can be the spatial distribution of public transport stops (accessibility of transport), spatial distribution of the number of parking spaces, transport network density, scatter of recharging points etc. Creation of the sustainable business development model is preceded by a choice of a strategy for the service development, which implicates the choice of the business location (head office and/or distribution points) to a considerable degree. In the process of business allocation, spatial indexation of a number of networks was undertaken, namely settlement networks as well as those of economy, transport, culture and entertainment, education, science, health care and others. The spatial indexation, in which a business may be potentially located, was performed on the basis of a previously prepared transport model of the Conurbation of Upper Silesia and Dąbrowa Basin (Polish: konurbacja górnośląsko-zagłębiowska) being an outcome of the Green Travelling international project implemented under the ERANET Transport III programme [40]-[42]. This model constitutes the source in building the adaptive model of sustainable business development (BEMA). The GT model was based on information from institutional databases, such as those of statistical offices used to determine the number of jobs within the area analysed (Conurbation of Upper Silesia and Dąbrowa Basin) [43], as well as non-institutional databases, e.g. the open-source OSM (Open Street Map) [44]. Such databases contain diversified data particularly useful while developing a formal strategy for business allocation.

Figure 3 illustrates an example of spatial distribution of the data acquired. It provides a map showing the distribution of the number of jobs (persons employed) within the area subject to analysis (understood as a stimulant of a certain service). This area was delimited within borders of what is commonly referred to as the Conurbation of Upper Silesia and Dąbrowa Basin. Its population exceeds 2 million and it comprises over a dozen municipalities inhabited by more than 100 thousand people. For the purpose of indexation of the space in question, the area subject to analysis was divided into 319 units referred to as spatial territories (operational division). Establishing the number of people working in individual spatial territories provided grounds for using such an item of data in order to analyse the options for ensuring sustainability of business development in the social aspect (one of stimulants) [45]. In this case, it means that territories of high social and economic potential are sought for the business‘s sake [46]. The specificity of the business’s development in the aspect of its sustainability may require that the former is allocated in such a point in the space which will correlate with a small, average or large number of jobs within the territory, or alternatively with the value of a different stimulant/destimulant. In this sense, the map provided in Figure 3 depicts a distribution of stimulants for sustainable business development in the area analysed. Maps such as the one in Figure 3 may constitute a useful tool supporting the sustainable development assessment under the BEMA model. Another group of data which may serve the purposes of sustainable business development are the non-institutional data, usually distributed along with open-source software, on the GNU GPL basis or as freeware [47].

Fig. 3 Distribution of the number of workers employed in individual territories [15].

Figure 4 illustrates an outcome of using a tool extracting data from open-source databases. Figure 4a shows the extracted data concerning selected aspects of the transport network in the conurbation analysed. In this case, the acquired data comprised locations of public transport stops (train, tram and bus), and traffic collectors (car parks, other parking areas) have been marked on the map. In order to compare the indicators obtained for different networks, the data being extracted in a manner shown in Figures 4a and 4b are aggregated in selected areas. An example of such aggregation has been provided in Figure 4c which illustrates the data extracted from OSM maps, concerning the transport network of the agglomeration analysed, subsequently aggregated in spatial territories (the cell colour in Figure 4c corresponds to the territory indicator value). With regard to the transport network, one should extract such indicators from open data sources which make it possible to minimise the environmental impact related to the provision of the given service, e.g. through traffic minimisation in the network or rerouting it.

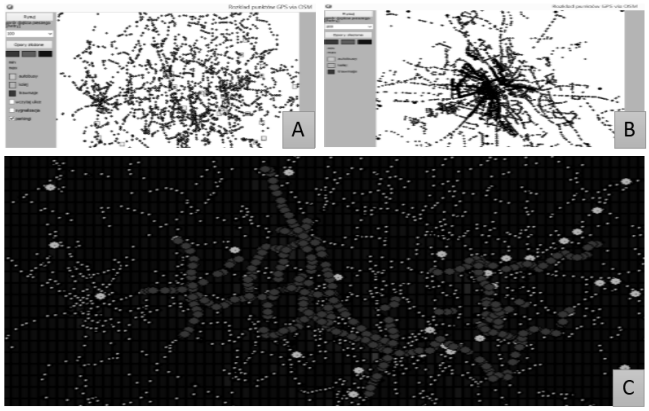

Fig. 4 Acquisition of data from OSM sources using the authors' proprietary tool:
a) visualisation of geolocation of public transport stops within the area subject to analysis, b) visualisation of geolocation of public transport stops within the territory of the Warsaw agglomeration, c) sample aggregation of transport network data from the area analysed.

Using the institutional and non-institutional databases for purposes of a practical example of application of the sustainable business development model proposed in this article, distributions of multiple variables were developed. Visualisations of selected variables across individual circulation territories have been provided in Figures 5 and 6. The colour of each spatial territory marked in these illustrations corresponds to the number of objects of the given type located within its borders (in this case, only selected stimulants proposed have been shown). Different spheres of inhabitants' activity were chosen for visualisation, namely shopping, official administrative matters, services, cultural activities, sports or education etc.

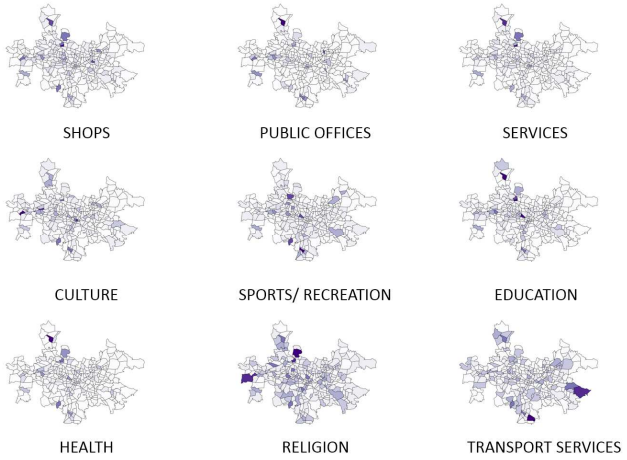

Fig. 5 Visualisations of selected variables in the area subject to analysis.

Fig. 6 Visualisation of population distribution in the area subject to analysis.

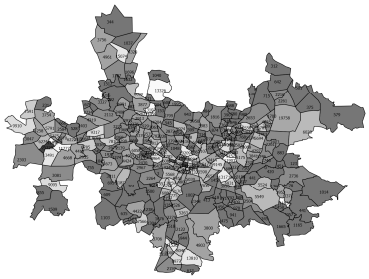

Fig. 7 Visualisation of distribution of jobs in the area subject to analysis.

Another variable characterising the area, considered relevant in light of the subject of this article, is the population of the area analysed. The following example was based on information acquired from the Central Statistical Office (GUS) database (stimulant visualisation provided in Figure 6).

V. Practical Example

In order to illustrate practical application of the BEMA model, the authors have analysed a case of a business providing highly specialised eco-friendly services for tourists

in the Conurbation of Upper Silesia and Dąbrowa Basin. Their services are assumed to ensure that the tourists coming to the conurbation are furnished with comprehensive assistance in the scope of transport (changing places), translation, entertainment, participation in cultural events, accommodation, meals, health care etc. It is proposed that this service should be implemented in such a manner that its environmental impact and encumbrance of the transport network can be reduced (obviously assuming appropriate demand). On account of the assumptions made, all the movement performed under the service in question will be based on public transport or eco-friendly vehicles. Bearing in mind the number of submissions received from potential clients under such a system, their spatial distribution and the immediate nature of the service, a temporary employment agency specialised in employee leasing has been chosen as the predominant format of economic activity [33]. The agency is to seek permanent collaborators among persons in disposal of eco-friendly means of transport (e.g. hybrid and electric cars). Moreover, by way of employee leasing, the agency is to hire students as guides (or rather assistants) for tours around the conurbation area (for various cultural and mass events). In the showcased project, the business in question will keep developing by offering innovative services (since no identical services are offered elsewhere in Poland) which minimise the transport network load and do not endanger natural environment. Minimisation of the business's environmental burden is assumed to be ensured by using individual means of eco-friendly transport as well as by commissioning students with the most adequate skills and, at the same time, residing at the nearest location to the place where the service is to be delivered at the moment when it is accepted for performance. In the case when the person assigned to the given job is not in disposal of an eco-friendly means of transport, he or she should see to its completion using collective transport. Such an approach makes it possible to apply the BEMA model in combination with the GT dedicated trip planner [40]. This planner enables the most environmentally friendly route to be set in any chosen transport network. Under such a model of the business development sustainability, the company must consider various potential locations for their offices (both head office and service points) in the conurbation with reference to the distribution of facilities and institutions supporting their operations (mainly hotels). Moreover, the company must also dynamically analyse changes in the distribution of business stimulants within the area analysed, and change the layout of their outposts in time as well as accordingly modify the parameters of their service (e.g. by temporarily employing more students with Chinese language skills). On account of the considerable rotation of personnel (temporary employment), incidental demand for large numbers of employees (seasonality of tourist circulation), variable characteristics of customers (different and periodically changing language groups, groups of different profiles like businessmen or seniors) or the mobility required of them, the company is seeking employees with specific traits, e.g. persons up to the age of 26, mainly students. Another factor of major importance from the perspective of development of the business described is the knowledge of places of residence and qualifications of persons below the age of 26 years (considered dynamic, open, proficient in foreign languages, familiar with the distribution of stimulants, proficient in using the Internet, capable of using a trip planner), which makes it possible to match the place of residence of a potential employee and the temporary location of the employer as well as the location of the object (facility) the latter intends to visit. In order to minimise the negative environmental impact of the service to be rendered, one must be familiar with the parameters of the transport network, and mainly of public transport. It stems from the need to adapt the working time and place of the potential employee delivering the service to the employer's expectations. Public transport does not function equally well throughout the entire day, which requires a particularly careful choice of the distribution of students' homes and places of education which would support rapid and unfailing provision of the service at the location where it is generated. Owing to such an approach, the traffic occurring in the transport network in connection with the service can be minimised. What also matters with regard to the service generation point is the knowledge on the distribution of hotels, sports and recreation facilities, large shopping centres, cinemas, theatres, night clubs etc. Correlation of these data sets makes it possible to appropriately choose both employees for the business and locations of its divisions. A division/branch office location (place where the employer is taken over) should be adapted to the distribution of the potential points where orders may be placed (hotels, railway stations, tourist information centres etc.). The goal of environmental efficiency of the project is pursued by minimising the range of travel by means of individual eco-friendly vehicles or by making smart use the public transport (using the GT trip planner). Having correlated the employees' places of residence with the locations involved in the service provision, one can eliminate a fair share of travel by individual means of transport, thus reducing the transport network load. Detailed analyses of environmental impact of the service in question have not been addressed in this article.

In order to acquire input data for preparation of the model of sustainable business development, the authors have chosen individual parameters describing the space and supporting the innovation implementation in the scope of the service planned. In one part (demand), the service provision is supported by such locations as hotels, catering points, entertainment and culture centres. What seems to be beneficial for the service provision in the other part (supply) is the locations where potential tour guides may reside (higher education schools, student campuses etc.). In order to implement the sustainable development model, values of selected simulant parameters (the problem of occurrence of destimulants has been disregarded in this article), describing characteristics of each of 11 municipalities in the area subject to analysis, were

correlated. The assumed goals were achieved by comparing thirteen parameters describing different systems (characterised by values of selected stimulants) in all spatial territories of the given municipality (economy, education, health care etc.). The relevant calculations were conducted for the entire area subject to analysis for the sake of comparison (they have not been presented due to the large size of the calculation table – 319x319). In the example discussed in the article, after a preliminary analysis of the entire conurbation, the area analysed was narrowed down to the territory of the municipality of Katowice.

Katowice R values	NoI	NoW	NoWP	NoSh	NoO	NoSe	NoH	NoC	NoR	NoS	NoB	NoT	NoE
NoI	1.000												
NoW	1.000	1.000											
NoWP	0.305	0.305	1.000										
NoSh	0.526	0.526	0.714	1.000									
NoO	0.115	0.115	0.632	0.529	1.000								
NoSe	0.296	0.296	0.752	0.867	0.515	1.000							
NoH	0.778	0.778	0.514	0.705	0.494	0.551	1.000						
NoC	0.134	0.134	0.583	0.519	0.488	0.686	0.428	1.000					
NoR	0.551	0.551	0.317	0.539	0.299	0.518	0.556	0.263	1.000				
NoS	0.400	0.400	0.130	0.135	0.034	0.209	0.336	0.325	0.415	1.000			
NoB	0.144	0.144	0.465	0.370	0.320	0.381	0.211	0.260	0.215	0.081	1.000		
NoT	0.044	0.044	0.042	0.177	-0.053	0.176	-0.047	-0.082	0.401	0.026	0.395	1.000	
NoE	0.654	0.654	0.333	0.603	0.416	0.443	0.800	0.363	0.499	0.392	0.107	-0.061	1.000

Table 1 Correlation of subsystems within the area subject to analysis – Katowice

Description: NoI – population, NoW – no. of workers, NoWP – no. of workplaces, NoSh – no. of shops, NoO – no. of offices, NoSe – no. of service points, NoH – no. of health care centres, NoC – no. of culture centres, NoR – no. of religion centres, NoS – no. of sports (recreation) centres, NoB – no. of businesses, NoT – no. of transport facilities and NoE – no. of education centres.

In Table 1, the colour yellow marks the correlation coefficient designated as almost complete ($r>0.9$). Green corresponds to very high correlation ($0.7<r\leq0.9$). Blue marks high correlation ($0.5<t\leq0.7$). The classification of the correlation coefficient values applied follows J. Guilford.

Table 1 provides a correlation of spatial variables describing 52 spatial territories of the municipality of Katowice in the scope of the chosen stimulants for the service implementation. Individual columns and rows contain numerical indicators (number of facilities/objects of the given type within the area analysed) for the chosen 13 networks (specific stimulants). Certain correlations in Table 1 may be purely statistical, and it is the task of the persons managing the business to indicate relationships in Table 1 which they consider relevant for the sustainable business development (substantiated choice of stimulants). The indicators contained in Table 1 are correlated in a system of territories (matrix of 52x13: 52 territories, mutual correlation of 13 stimulants). The average correlation ratio for the entire area came to 0.540769.

In the course of the analysis of the chosen businesses development sustainability strategy, following the principles of the model proposed (BEMA), an analyst is in disposal of a set of data concerning the correlations between individual networks: transport, tourism, entertainment, education, health care etc. The networks (stimulants which describe them) are compared with reference to any chosen area subject to analysis for which the relevant data are available. The conurbation area analysed features this functionality owing to the Central Statistical Office databases (business statistical numbers, population numbers) and OSM maps (there are also other databases not mentioned in the article, e.g. vehicle registers).

Using the BEMA model, one can alternatively perform a spatial analysis based on Tobler's first law, according to which "everything is related to everything else (in geographical space), but near things are more related than distant things" [38]. Researchers are unanimous in claiming that spatial units are subject to observable influences exerted by their neighbouring territorial units. In the context of this article, circulation territories affect one another in the spheres of the 13 variables analysed. The process of mutual impact between circulation territories depends on the economic, social and political changes occurring in these territories [32]. In terms of autocorrelation of different spatial parameters, the study entails the phenomenon of autocorrelation between values of the given property in the selected location and neighbouring objects. It is conducted with reference to local statistics of LISA (Local Indicators of Spatial Association), providing a more detailed picture of the spatial structure of the given process (in this case: impacts). This, in turn, makes it possible to track the distribution of values of the property being examined (or correlation of properties). Figure 8 shows the classification of spatial territories within the borders of Katowice. Each territory is classified as: HI-HI (high-high), LO-HI (low-high), HI-LO (high-low) and LO-LO (low-low). The LO-LO symbol indicates spatial territories of the municipality where minor traffic disturbances within the territory are accompanied by minor disturbances in neighbouring territories. Territories of small disturbances are favourable of the service implementation.

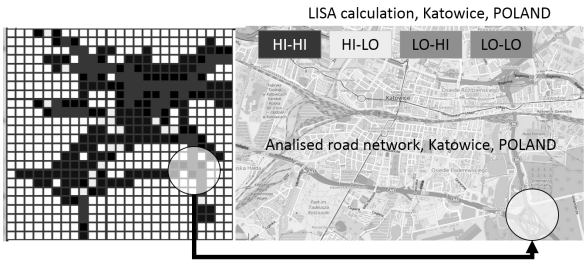

Fig. 8 LISA statistics calculated for Katowice.

Such an analysis as the one illustrated in Figure 8 enables elimination of spatial territories which, despite featuring stimulants of appropriate values, when correlated with one another, do not display good parameters of the transport network. Alternatively, this analysis allows for elimination of territories which prove inferior in terms of the values of stimulant parameters compared to adjacent territories (in which case, for instance, distribution of the product or service in the these territories may prove unprofitable).

Figure 9 shows the spatial distribution of the chosen parameters of different stimulants for the networks studied,

considered relevant from the perspective of the area in which the service analysed is to be rendered. Figure 9a depicts the distribution of places where students reside in Katowice and in adjacent territories. It shows the scattering of employees best matching the profile of the service to be provided from the functional and geographic perspective. Figure 9b illustrates the arrangement of territories where students are educated. It is important because they will not always travel to work from home, but equally often from schools after classes are finished (particularly in extramural studies). Figure 9c shows locations of hypermarkets in the area subject to analysis, as they hold some part of mass events. Then, in Figure 9d, the distribution of hotels in the municipality and in its direct vicinity has been depicted (places from which customers are collected and to which they are assisted). The scattering of pubs, restaurants and night clubs as well as cinemas, museums etc. has been presented in figures 9 e, f and g for obvious reasons (being stimulants decisive for the service).

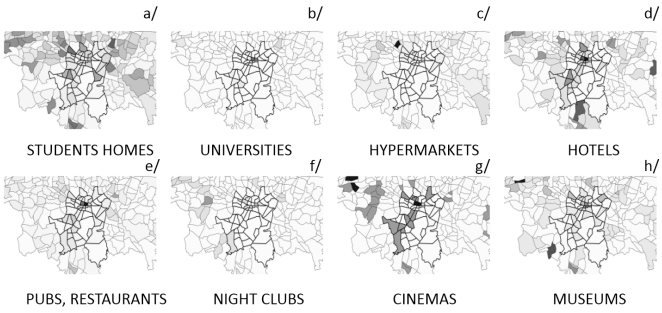

Fig. 9 Visualisation of spatial distributions of parameters considered relevant for the business analysed.

Having correlated the data provided in maps in Figures 9 and 10 with the business's location (head office/service points), addresses of customers and places of residence of those to provide the service (i.e. students), one is able to pursue to concept of sustainable development of the business analysed in conformity with its operational policy. Figure 10 shows the distribution of major performance and sports centres. Results of the correlation of systems supporting the business (intersystem correlation) have been provided in Table 2 (where four variables (S1...S4) have been selected as those which describe parameters of the four networks considered important for the chosen form of business activity).

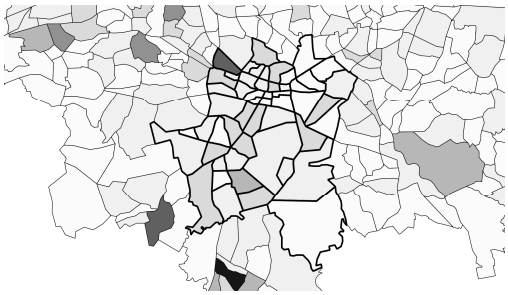

Fig. 10 Spatial distribution of major entertainment centres.

The assumption made for purposes of Table 2 is that the analysis comprises variables applicable to a client who intends to participate in a mass event in the city.

Coefficient r	Number of persons studying in the given territory (S1)	Number of students residing in the given territory (S2)	Number of hotels (S3)	Stadium, sports and performance hall, skating rink (S4)
S1	1			
S2	0.055274	1		
S3	0.23331	0.294453	1	
S4	0.08304	0.422934	0.215577	1

Table 2 Correlation of subsystems within the area subject to analysis – Katowice.

Based on the analysis of the values provided in Table 2, it was established that there was a certain correlation between the distribution of the number of students having their homes in individual territories subject to analysis and the number of hotels and large sports/performance centres. In the next step of the study, the data concerning the distribution of places of residence of potential employees were correlated with the distribution of qualitative data characterising the transport network (LISA statistics, Figure 8). With reference to the results of this procedure, individual territories inhabited by students in the area of Katowice were selected, in which they would be recruited for purposes of assistance for tourists reporting the need for a personal guide. Such student-related locations minimise the environmental impact of the service in question. Students living in considerable distances from the locations of the facilities which support the service provision are classified as the "backup". Having analysed the data provided in Figure 8, one can select the territories which allow students to reach the facilities visited by the customer using the shortest route or one where the LO-LO type territories are predominant (being characterised by a higher potential for fast and reliable travel to the working place, which also contributes to innovativeness of the service). Besides the quality of the transport network in the territories inhabited by students and in the target territory where the job is to be performed (also in transition territories, if there are any), one should assess the availability of public transport (distribution of the number of stops in spatial territories), the distribution of parking areas (Figure 4) etc. It is also possible to apply procedures of direct assessment of the number of connections by individual means of transport between the student's place of residence and the mass event venue. For that purpose, one can use a highly specialised trip planner, Green Travelling, developed under the ERANET programme (more about this subject in [40]-[42]). In Table 3, the application of the method proposed has been demonstrated by showcasing a customer willing to receive a comprehensive and eco-friendly tourist service in the area subject to analysis (appropriate variables have been selected with reference to this assumption).

Analyses of correlation coefficients for the chosen stimulants relevant from the perspective of development of the business

examined have been provided in Tables 2 and 3. With reference to an analysis of the data contained in the tables, the strong supply stimulant assumed for the sake of further calculations is the item of data describing the distribution of students' places of residence in the area analysed. Nevertheless, instead of the foregoing, one can also assume the stimulant defined by the distribution of the number of students attending higher education schools in the chosen area. The distribution of student homes and centres of higher education within this area is best correlated with potential locations where the service in question is to be rendered (hotels, pubs, restaurants etc.). The next stage was a test which consisted in randomly picking the points of deployment of potential employees in the territory of the municipality (proportionally to the distribution of stimulants within the area subject to analysis).

Coefficient r	Students, universities (R1)	Students, residence (R2)	Restaurants, pubs (R4)	Night clubs (R5)	Cinemas, theatres (R6)	Museums, galleries (R7)
R1	1.000					
R2	0.055	1.000				
R3	-0.002	0.344				
R4	0.341	0.490	1.000			
R5	0.015	0.294	0.256	1.000		
R6	0.124	0.244	0.437	0.224	1.000	
R7	0.243	0.253	0.417	0.173	0.271	1.000

Table 3 Correlation of subsystems relevant to the business.

For the selected locations of potential employees of the business, the spatial territories they inhabit were examined in terms of values of the characteristic illustrated in Figure 8. In this manner, certain employees were eliminated from the randomly picked group, namely those whose availability on demand could be limited (lower mobility) on account of unfavourable parameters of the transport network at their place of residence. In the next step of the process, one should match the location of the business's head office and potential branch offices to the distribution of demand stimulants. Based on such an analysis, the final choice of business locations was made as shown in the visualisation provided in Figure 11.

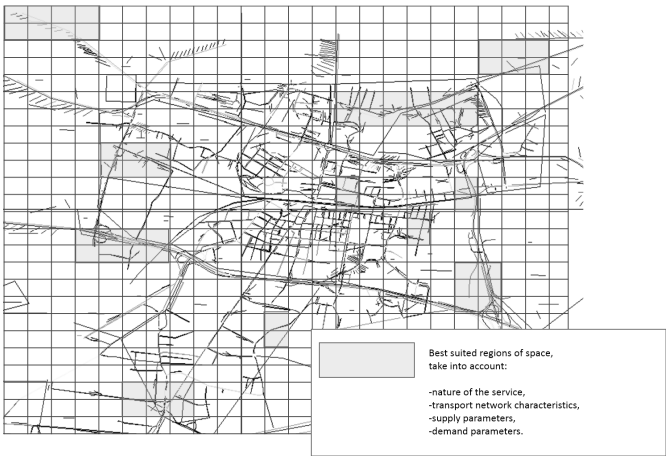

Fig. 11 Selection of spatial territories favourable for the business location in accordance with the model proposed (blue box).

VI. Conclusions

According to the authors, sustainable business development starts already when the service or product choice is made. Another matter of major importance is the selection of correlated variables (stimulants and destimulants) for different networks considered relevant from the point of view of the business profile, bearing in mind that its negative environmental impact should be minimised. For that purpose, specific studies must be conducted in order to determine endogenous variables affecting the success of the product or service offered by the business. In many cases, relations between such variables are completely unknown, particularly in cases of innovative (or niche) products and services. The relations between variables describing the services or products delivered by the business and those describing the relevant networks existing in its surrounding can be studied using basic statistical methods. Choosing variables from individual networks surrounding the business for purposes of the correlation procedure depends to a considerable extent on how the business's managers perceive and feel about the sustainable development idea. If it is the sustainable development through innovation, one should seek such networks and variables describing them which support the given innovation (product or service). Another aspect of the model presented in the paper is the matching between the business development sustainability and the parameters of the transport network through correlation with the transport network indicators (LISA procedure). In the study discussed in the article, this matching was assessed through measurement of the number of mutual influences (interferences) between vehicles in spatial territories. Spatial territories with a lower number of influences are supportive of the service development. Also other parameters of the transport network may be used in this procedure, such as those more linked with the operating profile of the given business. In broader terms, even the entire transport system may each time be correlated with the given business with regard to its sustainable development. The BEMA model presented in the article may be complemented with analyses performed using the DPSIR (Driving force, Pressure, State, Impact, Response) framework [48] and sufficiently extended to entail elements related to such aspects as e.g. transport accessibility of the given spatial territory or support for the suitable modal breakdown of traffic [49] and planning in management of development [3].

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