The State of Organization Interacting with the Surroundings. ERBV model.

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The concept of the state is the base sentence in thermodynamics and mechanics. In economics and social science, and particularly in management science, it is a very difficult multidisciplinary issue. In fact, it is not even entirely clear whether such a term can be introduced at all. Management looks for good estimates of axiological evaluations, which favors a search for quantitative descriptions of instantaneous states of managed organizations. Inspiration may be drawn from statistical physics and thermodynamics. The study shows that a particularly promising approach may be a combination of the utility theory and resource- based view (RBV). A description of the micro-macro balance between an organization interacting with the surrounding, where parametric variables are inside and outside the utility, defines a resource constant characterizing the system and being useful for the manager. The state can be defined as a function of capital exchanged with the surrounding, determined value of the resources, and internal and external utility. The optimization of management can be based on determining the linear operator (transform) of the current utility to the optimum one in the same vector space.

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Introduction

The problem of the physicalistic approach to management [1] remains an important issue from the perspective of computer-aid and semantic-models construction for decision-making under uncertainty [2-3], estimations of the effects of decisions taken [4], evaluations and analysis of the capacity to generate value [4-5], measuring the level of market share [6], etc. The principles of information systems design require explicit univocal numerical representations of the problem and the introduction of formal models of non-mathematical issues, which are typical of social sciences [7-8]. The main sources of inspiration are natural sciences, particularly physics and chemistry, which formally describe and theoretically explain interactions of matter with the surrounding [1-2]. A number of successful analogies between economics and thermodynamics are offered by econophysics [9-11]. Analogies connected with definitions of the state are particularly interesting here [9,11] as well as the use of thermodynamic principles in the analysis of macroeconomic behavior, where – instead of the temperature – the market index or GDP per capita are used, pressure is replaced by economic pressure, and spatial volume is understood as the market volume of the agent's free behavior [9]. Thus, as a logical metaphor for the state concept of the managed system, the Clapeyron equation and the definition of the state derived from statistical mechanics can be applied [12].

One of the basic management questions which are difficult to resolve is the evaluation of the economic state of the managed organization. A fundamental question must be pointed out here: *if a decision-maker acting under uncertainty requires the aid of a computer system, then he must accept the reductionist Cartesian approach to the problem, limitation of the set of analysed variables, reification in reasoning and accept a formal methodology*, e.g. from physics. This may not guarantee an exact solution to the problem, but it offers a pragmatically acceptable estimation of the range of possible solutions. From the point of view of management practice, such estimations provide satisfactory information because quantitative precision is less important than qualitative evaluations [13-15].

The best formal model describing the state of an organization interacting economically with the surrounding, inspired by physical descriptions of the state, is the resource-based approach known as RBV [16-19], where the organization is represented as a set of VRIN-class resources [1] offering a given usability. This set may have its defined topology, internal relations, and defined forms of interactions. It may be described qualitatively and quantitatively for its utility to be defined and estimated, similarly to the Debreu theory [20-22]. In this way the vector measure taken directly from a physical description of material objects is rational and often applied in economics, e.g. in the multicriteria analysis [4].

The aim of this paper is to extend the RBV model, allowing to analyse all classes of business problems, including those which failed. Additionally, by blending the theories of utility and resource, it identifies some synthetic indicators of axiological evaluations of the economic state of the organization and management activity, based on an incomplete set of data.

The model

The subject of management is a given organization regarded as a set of material and non-material resources, optimized according to the rules of the VRIO framework [6-17]. A formal representation is formed as an ordered structure of resources [2,23], understood as a given composite entity (structure) S = [U,O,R] determined on economic objects U, called an organisation, consisting of:

1 non-empty set U of material and non-material objects, called Resource
2 indexed set O of operations allowed on set U
3 non-empty, indexed set R of possible relations on set U.

Resources generate value, which in the general sense constitutes the aim of a business organization [14]. They are thus valuable *ad definitione*, as seen in the model. It is strictly related to the concept of utility [20]. The more added value a given resource generates, the more usability it displays. But utility understood in this way relates only to the estimations from the position of an internal observer. It is therefore necessary here to introduce the notion of internal usability. The particularly important characteristics of internal utility include the in-imitable and non-substitutable properties of the resource as well as the organizational ability to use the offered utilities.

Another aspect of usability is the quantity of created value exchanged with the surrounding [1-2]. It is one of the evaluation criteria assessed from the external observer's point of view. He carries out market evaluation of the firm (resource) when buying either its shares or the whole company as an organized whole. Therefore, the evaluation of external usability is not related directly to the price of products or services generated by the company, but clearly depends on the generated value and exchanged capital measured by VA[2] and EBITDA[3] respectively. However, the in-imitability and non-substitutability of the offered products or services are also important for potential investors. The market pressure will also grow when the rarity option of the analyzed resource is proved. In the case of non-profit organizations, the net loss related to costs of the services offered for the surroundings should be assumed as a parameter equivalent to the created value. EBITDA will be used further on in this paper.

Three parameters of the model have been defined: exchanged capital, internal utility and external utility. The net present value of the resources depends on these parameters. In order to describe the state, one needs a suitable state equation as well. To this effect, it is necessary to focus on some qualitative relations among the parameters of the presented model.

1. Internal utility $\mathbf{u}_{int}$ and external utility $\mathbf{u}_{ext}$ should be dimensionless and normalized to 1. It results from the fact that *the probability of value creation and having a measurable worth by any resource of the managed organization is not less than zero and does not exceed 1.*
2. The ability of the resource to value creation **c** is determined by EBITDA measured in capital units. The exact value of EBITDA is possible to calculate only *ex-post* by means of well-matured

[1] VRIN (Valuable, Rare, In-imitable, Non-substitutable). Key resources of the organization, necessary for value creation. See: http://en.wikipedia.org/wiki/Resource-based_view
[2] VA – Value added http://en.wikipedia.org/wiki/Value_added
[3] EBITDA – Earn Before Interest Taxes Depreciacion and Amortization (Net Profit) see: http://en.wikipedia.org/wiki/Earnings_before_interest,_taxes,_depreciation_and_amortization

bookkeeping methods. An *ex-ante* prediction of EBITDA is only possible to estimate by means of simulation methods.

3. The market value of resource **w** is estimated by stock pricing but may be also determined as NPV[4] at a given moment, assuming that net present value is related to the entire resource offered for sale (respectively, ENPV[5] is an appropriate indicator for non-profit organizations). *Ex-ante* estimations are non-deterministic, yet it is possible to calculate NPV with satisfactory accuracy for managerial decisions.
4. A non-complex relation should exist between EBITDA and NPV regarding the organization as a set of VRIN-class resources interacting with the surrounding.
5. The equation of the ERBV state will therefore be as follows:

(1) $$\mathbf{w} * u_{ext} = k_{RBV} * \mathbf{u}_{int} * c$$

(2) $$w = k_{RBV} * (u_{int}/u_{ext}) * c$$

where:
k_{RBV} – characteristic constant for a given set of resources for $u_{int}=u_{ext}$.
u_{int} – internal usability related to productivity of the resource.
u_{ext} – external usability related to estimated market value of the organization.
c – result of productivity expressed as EBITDA.
w – estimated value of the resource expressed by NPV.

Some properties of the state equation:

1. If u_{int} increases, then u_{ext} decreases. The value of the resource does not necessarily increase in time if its productivity increases. But any increase of internal usability automatically increases value creation. The arising excess of value created does not necessarily have to be exchanged, and therefore the expected ability for value creation **c** need not increase either (along with the expected decrease connected with production costs of unsold excess value).
2. The u_{int}/u_{ext} ratio should be interpreted as the micro-macro balance coefficient. When it is equal to 1, then the resource interacts with the surrounding optimally, and EBITDA reaches the Pareto value [2,24]. The organization remains in the economic equilibrium state of the Pareto type, derived from the Nash equilibrium [2].
3. The u_{int}/u_{ext} ratio depends on time to an insignificant degree, and it qualitatively characterizes the resources interacting with the surrounding. The weak dependence results from the tendency to maintain the micro-macro state of equilibrium while managing long-term interactions.
4. If $u_{int} > u_{ext}$, then $(u_{int}/u_{ext}) > 1$. This means the existence of an excess of creation of added value over market requirements. Consequently, the structure of VRIN resource is not optimum. The set of resources will tend to decrease the productivity or to increase capital allocations in the surrounding.
5. If $u_{int} < u_{ext}$, then $(u_{int}/u_{ext}) < 1$. It means that there is a demand gap on the market, which is an occasion for allocating some extra capital in the surrounding. The resource may increase the value creation process, or reduce demand.
6. If $u_{int} \neq u_{ext}$, then $(u_{int}/u_{ext}) \neq 1$. The set of resources offers opportunities for optimization activities.
7. Constant k in equations (1) and (2) is a proportional coefficient, characteristic of any set of resources in the defined business context (k_{RBV} resource constant is determined experimentally). For the same category of organizations, but different business contexts, the value of constant k should be different.
8. The external and internal usability are expresses as lengths of vectors defined on the usability vector space, and may be determined *ab-initio* by means of a procedure which is similar to the multicriteria analysis.

For a detailed analysis of the physical sense of resource constant k_{RBV}, equation (2) should be rewritten to form the following:

[4] NPV = Net Present Value; http://en.wikipedia.org/wiki/Net_present_value
[5] ENPV = Economic Net Present Value (extended calculations of NPV over benefits arising in the surrounding)

(3) $$k_{RBV} = (w/c)*(u_{ext}/u_{int})$$

In the Pareto state, $u_{ext} = u_{int}$, therefore $k^{opt}_{RBV} = w/c$, which may be interpreted as ($NPV^{opt}/EBITDA^{opt}$). Therefore, constant k_{RBV} is a characteristic value whose reciprocal may be understood as the effectivity coefficient of the resources in the optimum state. In business practice, these optimum values of utility are not known. We may only guess they exist. When taking decisions, the manager establishes a certain acceptable state of the resources which usually deviates from the optimum one. It suggests carrying out simulations of the optimized states, using calculus of variations [25] or the Monte Carlo method [26]. A theoretical estimation of the optimum value of the k_{RBV} constant allows the manager to take decisions which lead to maintaining a micro-macro balance in the long run. This is one of the main objectives for any organization functioning on the market – to maintain its competitive advantage for a longer period of time. In this way, the simple indicator k_{RBV} defined above, expressed in a numeric form, is suitable for comparison along time and in different business contexts. It seems to be the most welcome parametric solution for managers.

The utility in the ERBV model

In his fundamental work, Debreu defines the vector space of utility and proves the existence of general equilibrium [21]. However, the concept of utility in the case of ERBV should be considered in a wider context. The usefulness of the resource is defined in the vector space of utility characteristics V^K of dimension K. It means that in determining utility, some parameters, arbitrarily chosen by the manager, form the base of vector space, e.g. costs of resource maintenance, slack time of the resources, efficiency of the capital, non-imitable and non-substitutable properties, etc. These characteristics are chosen at a given moment and for a concrete business context. Therefore, the calculated utility is always *ceteris paribus* related to managers' subjectivity, yet there is no reason to doubt the rationality of such a practice. But regardless of the method of choosing the parameters, the formal calculations are subjected to same formalism, e.g. the game versus the surroundings [2,27]. It should be assumed that the manager acts towards an optimization of the result, excluding his possible behavioral decisions (i.e. those of limited rationality). Since different characteristics of the utility are expressed by means of various measures and scales, it is necessary to normalize the defined vector space of utility to the unity, restricting it to the range of real numbers [0,1]. The normalization of each characteristic is based on determining the maximum value, and calculating the ratio of the present to the maximum value. According to that, the 100% utility means the length of the vector equal to $\sqrt{k}$, where k is the dimension of the vector space of utility. Each utility is defined as a linear combination of its base vectors [25]. Since the dimension of space is finite and should be limited to the level of the six most important characteristics of the resource of the VRIN class, it may be concluded that *there is always a linear transformation of any utility to the optimum* [28]. That is the essence of the ERBV model for management: there is a necessity to find the optimizing transforms, knowing that they exist. This may be done e.g. by means of the successive approximations method [25.28].

The presented formalism based on linear algebra methods is well known to physicists and economists, but the choice of suitable utility characteristics of the resource still remains an open question. There is no strict definition of the VRIN class which would simplify reasoning [19]. Neither is there a univocal definition of the objective function of an organization to be accepted by all researchers. There is no doubt that a business organization should create value resulting in direct internal profit, whereas a non-profit organization should offer social services which have an economic impact on the surrounding, at the same time minimizing its own costs. It may also be agreed that one of the most important goals of the economic set is creating a long-term equilibrium with the surrounding while minimizing own costs. However, not all managers will agree that the social comfort and well-being of the staff should be taken into account regarding the utility of the resource. As a result, the formalization of processes charged with axiological subjectivity is a weak tool in comparing different experimental data.

Another aspect to be taken into consideration when analyzing resource utility is the existence of the so-called hidden utility [2]. It is mainly related to knowledge and information resources [29-30] and some interpersonal relations (formal and informal). One of the most important elements of a manager's work is discovering new areas of utility and revealing some tacit knowledge unavailable at a given moment but positively influencing business processes, as well as finding such relationships and possible interactions inside the structure of resources as to induce positive synergic effects of the VRIN resource utilizations. It means that some aspects of the utility description must be omitted in this formal approach. We must also be aware of the fact that this *ceteris paribus* of the model may strongly influence resource constant k_{RBV} defined in equation (3). It may be observed after implementing an invention or acquiring information with high qualitative merit. Thus the presented physicalistic approach must be subjected to strict tests by practicing managers as well as falsification processes in the Popperian sense [31]. No suitable criteria assessing the importance of elements of value creation by the organization, or their relation with usability, have yet been formulated.

However, the crucial issue here is the distinction into internal and external usability, and finding relationships between those two. Internal utility is regarded from the internal observer's standpoint. For him, the information about relationships within the structure S(U,O,R) is known, as well as the resource structure and business processes. The internal observer determines vector space V^K_{INT} [0,1] (dimension K over the body of real numbers from the [0,1] range) of the resource utility, assuming a set of usability characteristics as a base.

The external observer has no complete information about structure S. However, he has sufficient data about micro-macro interactions, based on a capital exchanged on the market, the organization's market position, market demand for products, possible substituents, etc. He can also have an opinion about the in-imitability and rarity of the resources. Relying on these data, he can form vector space $V^M_{EXT}[0,1]$ with dimension m < k. It is assumed that $V_{EXT} \not\subset V_{INT}$; so it may be concluded that both spaces are separate. The utility vector in both spaces may be presented as follows:

(4) $$\mathbf{u}_{EXT} = \sum_j \alpha_j z_j \text{ i } \mathbf{u}_{INT} = \sum_i \beta_i w_i$$

where: α_j are coefficients (weights) of the external utility component z_j (j = 1, … ,m); β_j are coefficients of the internal utility components w_i (i = 1, … ,k) and $\forall_{i,j}\ w_i \neq w_j$ and $\forall_{i,j}\ z_i \neq z_j$. These coefficients are chosen arbitrarily by the appropriate observer, suitably for the structure of resources and the context of their interactions.

Example:

An external observer defines the following qualitative characteristics of the resource utility:

1. Slack time in relation to sold time.
2. Cost of complaints in relation to total income.
3. Effectivity of capital.
4. Non-substitution and in-imitation properties of the resource.
5. Product diversification.
6. Value added in relation to bookkeeping value.

The measure, scale and importance weight for each element of usability must then be established, e.g. for slack time in relation to sold time. The time1/time2 ratio is dimensionless. The scale range – if the ratio equals 0 – means 100% impact on usability, if it is greater than 5% - it means 0 contribution to usability (but the manager can assume 10% or more as a zero point, expanding the scale range). Importance weight β_1 for the linear combination is assumed as 0.2 (also a subjective assumption). Therefore, assuming that slack time is equal to 3%, the suitable contribution to total usability may be calculated as: 0,2*(1-3/5) = 0.08

Proceeding in this way, one obtains all the elements needed to calculate the value of $\mathbf{u}_{INT}$ and $\mathbf{u}_{EXT}$ from equation (4). The length of the utility vector will be calculated from the formula:

(5) $$\|\mathbf{u}_{EXT}\| = \sqrt{\textstyle\sum_j (\alpha_j z_j)^2} \quad \text{i} \quad \|\mathbf{u}_{INT}\| = \sqrt{\textstyle\sum_i (\beta_i u_i)^2}$$

On account of the subjectivity of choice of importance weights by the manager, there is always a possibility of optimizing resource utility. It also concerns the choice of variables representing utility characteristics. Some of them may be replaced *ad hoc* when the business context suggests such a necessity.

A similar procedure may be applied in calculating external utility $\mathbf{u}_{EXT}$. In this case, the manager will use other characteristics of utility as variables, e.g.

1. NPV in the case of buying the resource.
2. Volume of sales of products and services offered by the analyzed resource.
3. Cost of including the analyzed resource in the existing supply chain.
4. Rarity of the resource.
5. Market positioning of the offered products.

As in the case of internal utility estimations, the same formalism will be used for external utility. The resulting value of $\|\mathbf{u}_{EXT}\|$ will be the basis for calculating relationship u_{int}/u_{ext} from formula (2). Another interesting question to resolve and interpret is expressing the internal utility vector in the base of external utility characteristic and *vice versa*. Such transformations will specify the scope of optimizing the management direction and thereby increase the range of applicability of the ERBV approach.

Conclusions

The extension of the classic RBV model describing the behavior of the organization in business processes onto some aspects of utility offers its better functionality in practice. It alleviates the allegation that the RBV theory only explains business successes, whereas failures are not described [19.32]. The ERBV model allows for a full interpretation of the interaction of organizations with their surroundings and to determine the optimum resource of the VRIN class. Coefficient $k_{RBV,}$ called *resource constant*, derived from the formulated concept, offers a manager easily obtainable information about the degree of optimality of micro-macro economic interactions in a given business context. At the same time, it is possible to formulate the state of the managed system in the form inspired by the Clapeyron equation, where the state parameters are the internal and external usefulness and economic variables NPV of EBITDA, representing a generated value and capital. Some external constraints and internal relationships are indirectly taken into account through the utility definitions. The level of accuracy may be limited by the choice of variables and their quantity. The presented approach allows ERBV to simultaneously take into account the subjective assessment of usefulness, as well as the influence of the manager's behavioral acts on the state of the organization. Simulation methods, calculus of variations and the perturbation theory can be used to optimize utility. The existence of a linear transformation to the optimal state suggests that management can focus on searching for a linear operator of such a transformation in the vector space of utility characteristics. An interesting aspect for further research is expressing the internal utility vector in the base of the external utility characteristic, which may lead to inferences concerning micro-macro imbalances. It may be concluded from the performed ERBV analysis that *an ideal economic system interacting with the surrounding is one in which the length of the vector of internal and external utilities are equal*. Then there exists a state of micro-macro equilibrium, which determines resource constant k_{RBV}. This methodology of the ERBV model is easy to apply in management practice.

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