Syst Pract Action Res (2010) 23:221–236
DOI 10.1007/s11213-009-9157-5

ORIGINAL PAPER

Systemic Model for Diagnosis of the Micro, Small and Medium Enterprises from Two Cities from the Countryside of the State of *São Paulo* in Brazil

Omar S. Donaires · Marília G. Pinheiro · Luciana O. Cezarino · Luiz H. Ostanel · Dante P. Martinelli

Published online: 1 December 2009

Abstract This article presents a proposal of a systemic model composed for the micro and small companies (MSE) of the region of *Ribeirão Preto* and the agents which influenced their environment. The proposed model was based on Stafford Beer's (Diagnosing the system for organizations. Chichester, Wiley, 1985) systemic methodologies VSM (Viable System Model) and on Werner Ulrich's (1983) CSH (Critical Systems Heuristics). The VSM is a model for the diagnosis of the structure of an organization and of its flows of information through the application of the cybernetics concepts (Narvarte, In El Modelo del Sistema Viable—MSV: experiencias de su aplicación en Chile. Proyecto Cerebro Colectivo del IAS, Santiago, 2001). On the other hand, CSH focus on the context of the

O. S. Donaires (✉)
Smar Equipamentos Industriais Ltda, Av Dr Antonio Furlan Jr 1028, 14170-480 Sertaozinho, SP, Brazil
e-mail: omarsd@smar.com.br

M. G. Pinheiro
Information Technology, Federal Institute of Education, Research and Technology from Sao Paulo IFSP - Campus Sertãozinho, Rua Américo Ambrósio, 269 - Jd. Canaã, CEP 14.169-263 Sertaozinho, SP, Brazil
e-mail: mariliapinheiro@gmail.com

L. O. Cezarino
Business Departament, Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo – FEA/USP, Rua Professor Antonio Palocci, 700 casa 23. Jardim Ouro Branco, CEP 14079-800 Ribeirão Preto, SP, Brazil
e-mail: lcezarino@gmail.com

L. H. Ostanel
Centro Universitário "Barão de Mauá" ou (University Center "Barão de Mauá"), Ramos de Azevedo Street, 423, 14090-180 Ribeirão Preto, SP, Brazil
e-mail: ostanel@gmail.com

D. P. Martinelli
Business Departament, Faculty of Business, Economics and Accountibilty of University of São Paulo campus Ribeirão Preto—FEARP/USP, Avenida dos Bandeirantes, 3900, FEA Bloco C, 14040-900 Ribeirão Preto, SP, Brazil
e-mail: dantepm@usp.br

social group applied to the systemic vision as a counterpoint to the organizational management view considered by the VSM. MSE of *Ribeirão Preto* and *Sertãozinho* had been analyzed as organizations inserted in systems that relate and integrate with other systems concerning the public administration, entities of representation and promotion agencies. The research questions: which are the bonds of interaction among the subsystems in this process and who are the agents involved? The systemic approach not only diagnosed a social group, formed by MSE of *Ribeirão Preto* and *Sertãozinho*, public authorities and support entities, but could also delineate answers that aimed the clarification of obscure questions generating financial assistance to the formularization of efficient actions for the development of this system.

Keywords Micro, small and medium enterprises · System thinking · VSM · CHS · Brazilian agribusiness

Introduction

The Systemic Theoretical Reference leads to the option of focusing on an entire system, differentiating itself from reductionist or simplest analytical approaches. Such approaches study only part of their real objects of study, leaving behind important influences and relationships with other systems and the environment where they live, isolating them and, therefore, not detecting causes and consequences related to the external factors (Narvarte 2001). The systems concept reinforces a different pattern, which overlaps a simple group of related parts and, moreover, initiates a coherent pattern that supplies meaning to the entire project formed by the interactive parts. For Checkland and Scholes (1994), there is also a common intention or a unit that significantly contemplates the idea of totality.

According to Narvarte (2001), the VSM is a systems model of support to the development and the organizational change. Created by Stafford Beer, it has been used as a conceptual tool to understand organizations, redesign them (when necessary) and support the change management. It transmits an innovative form of understanding the organizational structures, independently from the type of organization and activity sector.

On the other hand, the main idea of the CSH is to delimit critical boundaries, that is, a systematic effort in critically dealing with boundary judgments. The boundary judgments determine which empirical observations and considerations are relevant and which must be left behind in order to study one particular system. For the reason of mixing facts and values, boundary judgments have an essential role when the verification of the meaning and the merit of an object or system is necessary (Ulrich 1983).

In this article, these two systems models have been combined so that, when facing the results of a field research carried out in MSE of Ribeirão Preto and Sertãozinho, we could identify and characterize the interaction bonds among these companies, public power and promotion agencies. From this identification and qualification, the proposal of efficient actions will be possible in order to promote the regional development of this area and make it possible.

The Systemic Models

Checkland (1981), whose method is characterized by the application of the thought to the experience, as the one derived from the observation and deliberately projected

experiments, explains that science is a system of learning about the world, which aims to obtain the concise expression of the laws that govern the regularities of the universe, being those laws mathematically expressed, if possible.

The scientific method is inherently reductionist. This is the way we found to deal with the complexity. There are three meanings according to which the scientific method is reductionist. First of all, from the disordered variety of the world some items are selected to be examined in an experiment that is a simplification of the reality. Secondly, minimum necessary explanation is required by the facts to be examined. Thirdly, we accomplish the Cartesian advice to decompose the problems in smaller problems and analyze piece by piece. According to this, scientific thought is almost synonymous of analytical thought, (Vasconcellos 2005). Although this method has generated the view of the modern world, the reductionist approach is a way of preventing and avoiding the complexity. This aspect can be understood as a limitation in the case of social sciences, given the complexity of their phenomena and the difficulty of reducing them into experiments in a laboratory controlled environment. The "management science" presents difficulties to solve these problems. Consequently, there is an incentive for the search of alternative paradigms instead of the one related to the natural sciences, in order to apply the rationality to the discoveries of the experience.

The system theory can be seen as an alternative paradigm, as a complement to science itself, characterized by a holistic and transdisciplinary approach, in contrast with the Cartesian reductionism of the scientific method. In order to become systemic, a particular object must be related to a complete area or, more than that, must be related to a system considered as a whole (Checkland and Scholes 1994). Thus, "the systemic" term comprises a system in its totality, without leaving behind influences and relationships with other systems and the environment. The isolation of the parts makes it difficult to identify causes and consequences related to external factors (Narvarte 2001) and to the interrelationships. To sum up, the systems concept refuses to consider a system as a simple group of related parts. For Checkland and Scholes (1994), there is also a common purpose or a unit that contemplates the idea of meaningful totality.

The systems approach is based on the General Systems Theory and the Cybernetics. The General Systems Theory was created by the German biologist Ludwig von Bertalanffy (1968), who introduced the concept of open systems and elaborated their general principles based on studies of thermodynamic and biological systems. Concerning the Cybernetics, Norbert Wiener (1948) has been considered its precursor.

However, there is eminent difficulty to make the pure theoretical concepts of systems work in the practical reality of social organizations. The systemic methodologies had been developed to guide the practical application of these concepts and, thus, to make wider and more complete analyses of complex systems possible, especially those contemplated by reductionist models. Martinelli and Ventura (2006) present a compilation of the concepts, methodologies and applications that compose the systems approach.

The VSM (Viable System Model) and the CSH (Critical Systems Heuristics), presented below, are examples of the scope of the systems approach and the diversity of tools that it offers. Beer (1985), through the VSM, tries to make a real alternative to support the administration of human activity systems available, by means of the study of its organizations and structures, within the premise to fulfill or to try to fulfill the condition of being viable, as a single requirement. A viable system is a system capable of an independent existence, despite of counting on the influences of an external environment. Generally, when it is said that a company/organization is viable, this viability is associated with the economic viability. But, according to Beer (1985), this is a wrong idea. According to

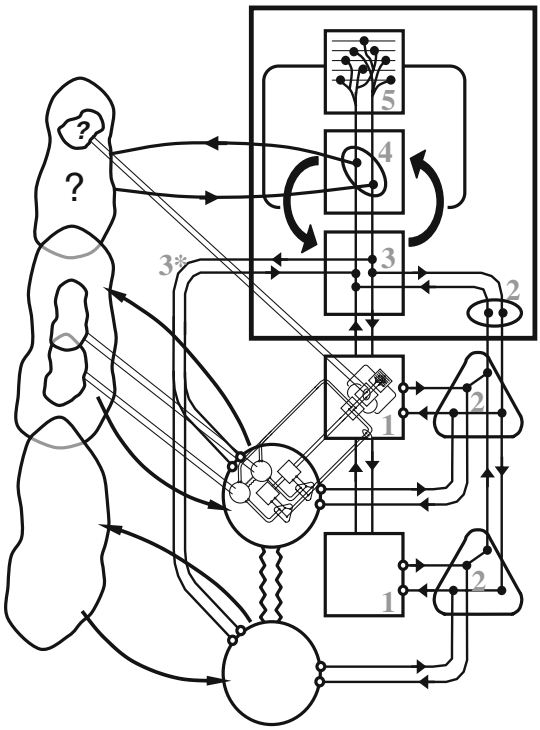

Fig. 1 VSM of two recursions, *Source* Beer (1979, p. 321)

Espejo and Harnden (1989), a viable system exists in an environment that is beyond the knowledge and control of the people of the system. According to Descartes (1998), the organization interacts with the environment in order to develop its activities and the management has to guarantee that these activities are, in fact, developed.

The VSM, illustrated in Fig. 1, is an example of a systemic-cybernetic model, based on the science of the communication and the control. The model comprehends five basic subsystems necessary to guarantee the viability of the total system, that is, its capacity to maintain an independent existence. The activities of the organization are performed by a group of subsystems or System One. System One is the implementation system, also called unit of organization that comprehends the independent units of operation in interaction with the external environment and its respective management. The organization also includes some mechanisms of local coordination or System Two. System Two is the system of coordination of the activities of several "Systems One", that is, of several autonomous units of organization. System Three is the control system, responsible for the synergy of the organization composed by the autonomous units. System Three manages internal and immediate activities, in order to guarantee the balance of the internal environment and, thus, the viability of the organization in a short term. It includes the system responsible for sporadic auditing that the meta-system directly carries out in the operations. System Four deals with environmental orientations and it is the intelligence system that makes the integration with the external environment and carries out the prospection of the future. It is responsible for the viability of the system in the long term. And, finally, System Five, that is the policy system. It defines the values and intentions of the organization that

guide the balance between the concerns of short and long terms of Systems Three and Four respectively. The VSM suggests that the organizations should work according to the principle of recursiveness, defined as: "in a recursive organizational structure, each viable system contains one or more viable systems and at the same time it is inside another viable system" (Beer 1985).

CSH (Critical Systems Heuristics) is a methodology for reflexive practice based on the concepts of the systems thinking. The Greek verb *heurisk-ein* means to find or discover; heuristics is the art of the discovery. Thus, the CSH is a tool of discovery toward the identification of relevant questions to the problem and the solution strategies. This process of discovery, Ulrich (2002) says, needs to be self-reflexive with respect to the presuppositions that flow from the judgments themselves. In the science of administration and other applied subjects, heuristic procedures serve to identify and explore relevant aspects of problems, questions, strategies, in contrast with deductive methods (algorithmic) which face the solution of logical and mathematically well defined problems. The professional practice does not exist without heuristics, because it often deals with *soft* problems (ill-defined, qualitative problems) in which the answers will depend on personal interests and opinions. CSH presuppose that the definition of all problems, proposed actions and the evaluation of the results depend on boundary judgments. Those judgments would define the boundaries among subsystems, to which the propositions would be valid or not (Ulrich 1983). CSH offer twelve questions as a guideline to: establish bounds among the reference systems; help to identify the boundaries which were not realized and promote the use of the systems thinking by means of the elaboration of a critical competence of unfolding boundaries that do not depend on any *expertise* in the subject in question (Ulrich 2000). CSH, based on the critical philosophy and the radical sociology, was conceived in order to identify and debate the values, beliefs, intentions, points of view and personal interests that inevitably appear in all the representations or projects of social systems.

Figure 2 presents the CSH conceptual scheme that adopts the paradigm of the "purposeful systems". A purposeful system is a system that is self-reflexive concerning its normative implications, considered not only by the view of those who are involved, but also of those who are affected, and it has autonomy, at least partial, to determine its client, its purposes, finally, its reason for existing. "Partial autonomy" means that the system can carry out its own will when choosing its goals. CSH indicate three dimensions of problem solutions of the purposeful systems: the inquiry, the action and the evaluation. For this reason, twelve categories are organized in four groups. The categories said to be pragmatic mapping categories, once their intention is to capture the phenomenal expression of the human intentionality which is part of the social reality. The categories have three purposes: (1) applied in the "is" mode, it performs the systematic identification of the current boundary judgments; (2) applied in the "ought" mode, it performs the identification of the alternative reference systems to define a problem or evaluate a solution proposal; (3) restrictively testing any intention of knowledge, rationality or improvement that is based on boundary judgments. It is the third application that leads to an emancipatory use of the systems thinking.

Martinelli (1995) summarizes the relevant contributions to the evolution of the administration theory and emphasizes the need of a new paradigm, reinforcing the use of systems methodologies for a systemic-evolutionary orientation. The systemic-evolutionary approach meets Ulrich's studies (Ulrich and Probst 1984) and the administrative focus in St. Galen (Ulrich and Krieg 1972). The annals of the I Brazilian Conference of Systems (I *Congresso Brasileiro de Sistemas*) present a collection of articles that demonstrate the application of the systemic view, of the VSM, SSM and CSH in several knowledge fields

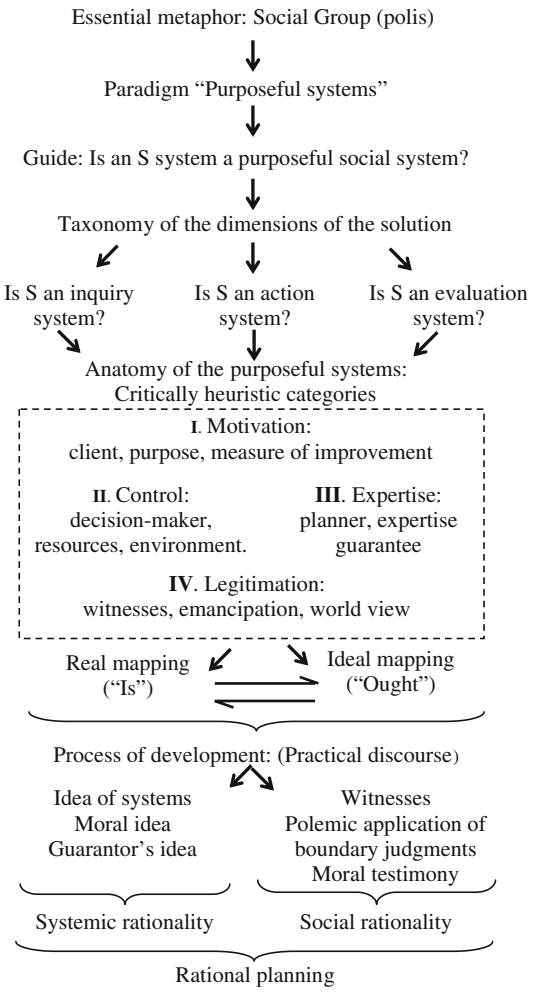

Fig. 2 Approach of purposeful systems, *Source* Ulrich (1983, p. 341s)

and in professional practice. The articles illustrate the application to a superior educational institution (Machado Neto et al. 2005), to a financial institution (Beltrán and Cezarino 2005), to a marketing company (Cezarino et al. 2005), to the elaboration of entrepreneur strategies (Camargo et al. 2005), to the process of software development (Donaires 2005), to a project to a infoexclusion reduction (Pinheiro et al. 2005), to the groups of companies (Ghisi 2005), to the integrated accountancy (Bertholo and Camargo 2005) and to the international relationships (Ventura et al. 2005). Donaires (2003) applies the Soft Systems Methodology SSM and the VSM to the planning and control of multiple concurrent projects of development of new products and solutions in the area of industrial process automation.

The Field Research

The field research evaluated by the theoretical model considered here was carried out from April 2006 to May 2006, and had a sample of 115 companies, 79 in the city of Ribeirão

Preto and 36 in the city of Sertãozinho. The sample is not representative; however the analysis of the results allows a better understanding concerning the management difficulties and the support that is offered to the regional MSE. The companies which are part of the sample were selected according to the following criteria: belonging to the MSE scope, and being located in the cities of Ribeirão Preto and Sertãozinho. The application of the questionnaire was accomplished through the filling of questions structured for the interview with the company representatives. In order to have a better view of the results, the data from each city were analyzed separately.

MSE of Ribeirão Preto

From the seventy-nine researched companies, in 15.19% the interviews were accomplished with partners/owners, in 81.01% with employees in general, and in 3.80% with autonomous job servers. It is important to observe that the employees who are not owners are fully trusted by the organizations. The predominant age level of the interviewees is under 35–83.54%. None of the interviewees was more than 55 years old.

Taking into account the interviewees' period of work at the companies: 48.12% had at the moment no more than three years of work at the company; 15.18% from 3 to 5 years; 22.78% from 5 to 10 years; and 13.92% above 10 years of work at the company. Although the individuals generally played several roles at the same time in the MSE, they were questioned about their hierarchic level. Among the respondents: 27.78% belonged to the strategic level; 29.17% to tactical level and 43.06% to the operational level. Concerning the performance sector, the research demonstrated a concentration in the service contribution and commerce, a characteristic of *Ribeirão Preto* city.

The research evidenced that, in *Ribeirão Preto*, the investigated companies had reached in their cycle of life the maturity level out of the mortality statistics presented by the Brazilian Service of Support to the Micro and Small Companies—SEBRAE. Only two companies are still in market adaptation stage (up to three years of existence). Ten companies are from 5 to 10 years old, and 57 are above 10 years old, and ten respondents did not specify the foundation time. Regarding the biggest difficulties noticed, even though the investigated companies had already been established in the market, the biggest difficulties found among the respondents were the high competition and the new competitors, being 24.29% of the answers. Another relevant factor is the staff management. Many people claim that there is a lack of qualified personnel; others claim that they prefer to train their employees; however this investment is not always possible due to the high costs and the reduced number of employees. Difficulties in the staff management represent 20% of the answers. The lack of financial resources 17.14% appears as the third main difficulty. The lack of planning appears in fourth place (14.29%).

Concerning the origin of the financial resources used by the investigated MSE, 52.7% prefer to operate with their own resources—personal or from family members—and they only appeal to other sources as a last resource, preferring not to pay interest taxes and financial charges. Regarding the municipal, state or federal public financing, only 8.57% of the companies use some form of financing. From the total of companies, 38.24% evaluate the access to the public financing as bad or awful.

In the interviewees' opinion, the most important factor for the company success is the good planning of the activities and the organization (61.11%). Concerning the other factors, we emphasize: good business management (20.83%); prevention of personal problems (5.56%); differentiated products and services (5.56%). Only 4.17% mentioned that

the governmental support policies to the micro, small e medium companies are important factors for the good development of the companies.

Questioned about the knowledge of an adequate public place for the installation of a company, such as industrial districts, polar regions or business incubators, the answers demonstrate the lack of public support for this factor. From the interviewees, 89.55% said they do not know any adequate public space. And none of the companies from the research uses a space like that. Concerning the public technological support, the main difficulties of access to the programs are: lack of information about those programs (54.69%); they do not consider the needs (20.31%); bureaucracy (17.19%); e slowness in the process (7.81%). The existing public exportation programs also suffer with the lack of information. Only 1.45% of the interviewees know some public exportation program.

In this research the support entities to the micro, small, and medium companies had also been evaluated. The results pointed that 49.28% of the interviewees claimed to have no conditions to evaluate the Federacy of the Industries of the State of São Paulo and the Center of the Industries of the State of São Paulo (FIESP/CIESP); only 17.39% evaluate their performance as "good". For SEBRAE, 30.38% of the interviewees evaluate their performance as a "good" one. 36.23% evaluate the performance of the Commercial and Industrial Association of *Ribeirão Preto* ACIRP as "good". The performance of the Municipal Government was evaluated by 35.62% as "bad" or "awful".

MSE of *Sertãozinho*

Thirty-six interviews were accomplished in *Sertãozinho*. Among the interviewees, 36.36% are partners/owners and 63.64% are employees in general. The majority of the interviewees were between 25 and 35 years old (42%). The number of respondents younger than 25 years old (31%). is also representative. Only 8% were more than 55 years old. Concerning the interviewees' period of work at the companies, 50% had no more than 3 years of work at the company; 25% from 3 to 5 years; 10.71% from 5 to 10 years; and 14.29% above 10 years of work at the company. Among the respondents, 44% belong to the strategic level; 16% belong to the tactical level and 40% to the operational level.

Concerning the size of the investigated companies in *Sertãozinho*, there is a high concentration of companies that have a monthly income below fifty thousand 'reais' (R$50.000). In terms of number of employees we can also observe a reasonable concentration of small-sized companies, i.e., with less than 20 employees.

Concerning the performance sector, the industries have a considerable participation in the research (23%), in an activity that, by the way, characterizes the vocation of the city. Sertãozinho owns some industries in the metallurgy, machines and equipment area, and the sample is coherent with the reality of the city, even though we did not have the pretension of having a sample that statistically represented the focused population.

We can affirm that the investigated companies in *Sertãozinho* are "mature" in their majority; therefore 58.06% have existed for more than 5 years. In 37.14% of the investigated MSE, the main origin of the financial resources comes from their own; the alternative is banking loans chosen by 22.86% of the interviewees. In the total, 20% of them negotiate stated periods with their suppliers.

The biggest management difficulty for the companies of *Sertãozinho* is the high level of competitors (35.29%). The second place concerns the lack of financial resources (26.47%), followed by the difficulty with the staff management (14.7%).

According to the interviewees' opinion, the most important factor for the company success is the good planning of the activities and the organization (59%). Concerning the

other factors, we emphasize: good business management (27%); differentiated products and services (11%); economic situation of the country (3%).

Concerning the financing, 54.84% know about municipal, state or federal public programs for this purpose. However, none of the investigated companies uses any type of public financing, although the difficulties in getting it. Questioned about the knowledge of an adequate public place for the installation of a company, such as industrial districts, polar regions or business incubators, 48.39% say they know at least one of these places. And only 11% use some of these spaces.

Concerning the public technological support, the main difficulties of access to the programs are: lack of information about them (64.29%); bureaucracy (14.29%); they do not consider the need (10.71%); and slowness in the process (10.71%).

The existing public exportation programs also suffer with the lack of information. Only 7.14% of the interviewees know some public exportation program, although only 40% of the companies which use those programs consider them good.

The support entities to the micro, small, and medium companies received the following evaluation: 51.72% of the interviewees affirmed they do not have conditions of evaluating FIESP/CIESP, 27.59% consider their performance "good"; SEBRAE, for 60% of the interviewees is considered "good"; ACI *Sertãozinho* got the same results from 24.14% of the interviewees; the Municipal Government was evaluated as "bad" or "awful" by 36.67%.

The Proposed Model

The proposal of the elaboration of a systems model consists in capturing the collected information in the whole process through the interviews and the results obtained from the field research.

In order to explore the potential of the systems approach, the Viable System Model (VSM) by Beer and the Critical Systems Heuristics (CSH) by Ulrich were combined in this work. Figure 3 visually explains the three steps involved and the way the context approached was treated by the systems methodologies.

CSH contributes with the critical insight and the heuristic treatment. Applied to the current situation of the MSE, raised through the interviews and the field research, the twelve boundary questions in the "is" mode revealed their heuristic potential. The answers to those boundary questions lead us to relevant questions that will help in the elaboration of a useful systems model, consistent with the reality. VSM contributes with its power of diagnosis and its capability of dealing with the complexity. VSM allows describing the wide context in which the reality of the MSE is inserted, exploring the communication and system control mechanism, and diagnosing its capacity of self-organization and adaptation to the inconstancies of the environment. Finally, the 12 boundary questions in the "ought" mode, applied after the effort of modeling and diagnosing the VSM, helped to refine the understanding of the system, taking into account the relevant aspects and the diagnosis identified in the two previous steps.

The analysis and the modeling, including the answers to the CSH boundary questions and the diagnosis done by the VSM, were based on the collected information from the investigations about the municipal, state and federal public policies, from the interviews accomplished with representatives of the public power organs, and from the results obtained by the field research.

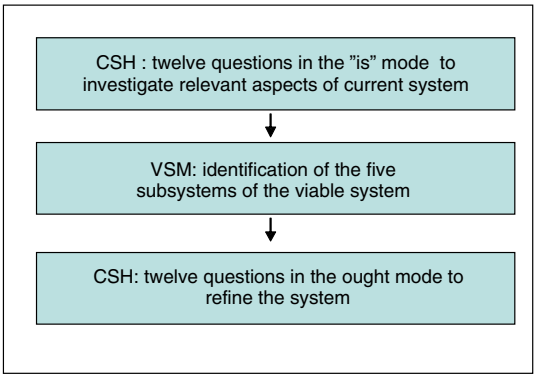

Fig. 3 Combined application of CSH and VSM

Investigation of the Relevant Aspects of the Current System

Table 1 presents the respective boundary questions in the "is" method, according to guideline proposed by Ulrich (1983), and their answers. The answers are not systematic, only compiled in order to be analyzed afterwards in the model. In the following questions, the system "S" is composed by the MSE, the support entities and the public power organs and the relationships among them.

Table 1 helped to identify some relevant and crucial questions for the treatment of the system and delimitation of the bounds among subsystems.

The three-first questions refer to the category of the client. There are support policies with interesting purposes, but they do not focus on the purpose and the client they intend to benefit. Even the policies which directly face the MSE need some indicators or measure which could translate the degree of success of these policies when beneficiating the MSE as clients.

Questions 4–6 refer to the category of the decision-maker. The real decision-maker is the public manager that acts through the tax and fiscal legislation, the actions of improvement of the financing conditions, and the creation of adequate infrastructure. Some environment conditions are naturally out of his control.

Questions 7–9 refer to the category of the social planner or system designer, role performed by the support entities. They know the reality of the MSE better and develop works that can coordinate efforts from public power organs, from educational and research institutions, and from the MSE entrepreneurs.

The ninth question presents the key issue of the system. None of the actors can directly assume the role of system guarantor, because of the lack of an indicator to measure the effectiveness of their actions. This situation compromises the surviving conditions of the MSE.

Questions 10–12 refer to the category of the witnesses of the affected ones. Nowadays, the MSE interests may not be represented or translated in the policies. The MSE seem not to be recurring to the support entities. A linking connection between the MSE and the public power organs is missing. Although the world views seem to be consensual concerning the objective desired by the system, they diverge concerning the commitment to the system sustentation and the fulfillment of each participant's responsibilities.

Table 1 Answers to twelve boundary questions in the "is" mode

1. Who is the real client of the system S?
   There are several federal and state policies, but some of them seem to be more directed to the community than to the needs of the MSE, and present traces of assistance instead of stimulating the productive activity.
2. Which is the real purpose of the system S?
   There are several disconnected policies, with the most varied purposes. In some cases, the purpose becomes ineffective. The difficulty of access to credit, for example, inhibits the growth instead of promoting it.
3. Which is, considering the consequences of the system S, its internal measure of success?
   During the investigation, no metric was identified. In some cases, the lack of resources obstructs the obtaining of measurement of indices. In other cases, not even an operationalization of policies is clear, or even its effectiveness.
4. Who is really the decision-maker, i. e., who can really change the measure of success?
   Currently, public power organs have the power of decision. Some support entities also play an important role, but their actions seem to be ineffective because of the lack of political force.
5. Which conditions of successful planning and implementation of the system S are really controlled by the decision-maker?
   The public power controls crucial factors, as the tax and fiscal legislations, the infrastructure, and long and short financing. However, there seems to be no worry with the effectiveness of the policies in the state and federal scope. The support entities try to influence some factors, as the straitening of the commercial relationships with other countries, the access to exportation, etc.
6. Which conditions are not controlled by the decision-maker, i. e., what does "environment" mean for him?
   Macroeconomic aspects are hard to be controlled, and others, as the international economic situation, are completely out of control. Although the public power is responsible for creating conditions to education, the qualification of the local labor force is not under its control, because it depends on complex aspects, as the historical and cultural inheritance.
7. Who is really involved as planner?
   The authorship of the policies is divided between the legislative and executive powers.
8. Who is involved as an "expert", what kind of expertise is it, which role does he really perform?
   The support entities. Their expertise is the knowledge of the difficulties of the MSE and the interaction with the companies. The universities also participate in some projects.
9. Where do the involved ones seek the guarantee of the success of the system S?
   Some support entities wager on the creation of a culture of entrepreneurism. Others believe in the integration and cooperation among companies, government and universities, in order to increase the productivity and the capability of exportation, negotiation with the provisioners, new investments, training of human resources, technological development.
10. Who, among the involved witnesses, represents the concerns of the affected ones? Who is or could be affected without being involved?
    There are indicators of the lack of representation of the MSE interests in the public organs. These interests are probably more represented and defended by the support entities.
11. Do the affected ones have an opportunity to emancipate from the experts and take their destiny in their own hands?
    The current policies present traces of oppressiveness. The solution to the emancipation seemed to ignore the policies and appeal to their own resources, i. e., an option for the isolation in exchange to independence.
12. What is really the world view implied in the system S? Is the world view from one (some) involved or from one (some) affected?
    The support system seems to have a very fragmented view. Disconnected policies and relevant efforts of the support entities may be interpreted as attempts to solve isolated problems. The MSE seem abandoned. The public power does not demonstrate any interest in investing in the sector and it seems to reduce its role to a mere assistance. The support entities play their technical role but do not have the power of decision.

Identification of the Five Subsystems of the Viable System

According to the steps proposed in Fig. 3, and based on the answers from Table 1, the VSM model was applied and its five subsystems were delineated. The effort to identify the five subsystems of the VSM method helps to identify the lacks and imperfections that compromise the viability of the system.

System One is also called implementation. It consists of primary and subsidiary activities of production of products or services that define the identity of the organization. The primary tasks have their own channels of information to communicate with their environment concerning the daily requirements. The environment is very complex and the information related to the system must be attenuated before reaching the system (Descartes 1998). In this context, we may consider the operation of the MSE as System One or implementation system. According to Fig. 1, the viable system would be the productive part of the company (industrial, operational) and the administration would be represented by the direction or management of the MSE itself.

A viable system also has subsystems to coordinate the functions of added value, and the primary activities involved. The coordination of the System One is seen as another system, System Two. In this case, this role of coordination can be attributed to the support entities (ACI, SEBRAE, CIESP) of each city. Because there is not an organ that centralizes those entities or administrates them, or administrates the MSE, the entities exist only to create representation in the government scope and to support the MSE. There is not a traced hierarchy that links the entities to the MSE, and there is not property of the companies. The entities only play a role concerning the orientations and representation of the MSE interests. This situation reinforces the idea that they constitute the System Two.

Following this, there is System Three of the VSM, called by Beer (1985) as here-and-now, because it is in charge of the immediate control of the activities. Its noblest function, before performing a bureaucratic control, is the maintenance of the cohesion by the exploration of the synergy in the organization. System Three is responsible for the definition of the organizational policies, for the negotiation of the resources with System One, which owes it the account render. In the case of the system of the support policies to the MSE, this system identifies itself with the role accomplished by the public power. The current policies, as pointed by the application of the CSH, have failed in promoting the synergy. The command axis that should respond by the cohesion of the system as a whole seems, in the contrary, by the excess of bureaucracy, to be the responsible for its disintegration, characterized by the independence and the relative isolation of the MSE.

System Three* of the VSM is part of the System Three and is characterized by the examination of the functioning of the autonomous activities of the organization sections and its objective is to report the problems found. It diminishes the complexity of the operational tasks of the organization. Its activities are sporadic and highly varied. In this research, we can consider that the role of System Three* may be performed by the local governments. The mechanism of verification is strongly submissive to the state and federal governments, however in local terms we may not consider the municipal governments as administrators of the companies, but as verifiers.

System Four is dedicated to the view of the future and attends the external environment of the company. It is called by Beer (1985) as outside-and-then. It concentrates its attention to the company's strategy and is essential to the adaptation of the organization. Considering this research, we could identify System Four (intelligence) with one agency or ministry of development of the federal government. Unfortunately, it seems that there is not a single actor who could perfectly play the intelligence role in the system, as proposed

by Beer. This lack creates an imperfection in the establishment of long-term strategic planning and compromises the capacity of the system survival, because it weakens the system defenses as a whole against the environment influences.

Finally, System Five consists of the directive structure of decision. Sustained by Systems Three and Four, it will command all the organization conscious of its internal and external complexity. System Five can be defined as the state or federal government, depending on the number of levels which are chosen to the application of the VSM model, nevertheless it is the clearest representation of the general policies of the system.

Refinement of the System

According to the approach proposed in Fig. 3, the refinement of the support system to the MSE will be conducted by the application of the CSH and the answers to the twelve boundary questions in the "ought" mode (Table 2).

The answers to questions 1 to 3, about the client, lead us to think about a system related to the specific needs of the MSE, capable of measuring the degree of efficiency to benefit them, and capable of promoting the sustained development of the MSE through an integrated group of policies.

The decision-maker, subject of the answers to questions 4–6, would still be the public power, acting in a less bureaucratic way in the implementation of favorable conditions to the development of the MSE, and contributing to the creation of an opportune environment for the fair competition without arbitrary interferences.

The support entities should be more active before the public power and as promoters and integrators of efforts from all the specialists qualified to the definition of adequate policies to the MSE, according to the answers to questions 7–9, about the experts.

Finally, the answers to questions 10–12 help us to visualize a more participative system, in which the entrepreneurs practice their citizenship before the public power, directly and indirectly participating in the decisions through the support entities, legitimate representatives of their interests. The support system should not be characterized by paternalism, or by the blind defense of interests of the MSE. It should take into consideration the systemic set as a whole that includes the community, aiming the local development. At the end of the day, the sustained development of the MSE should be aligned to a strategy of local development.

Final Remarks

According to Vasconcellos (2005), the systems thinking is a new view, a new set of presuppositions, a new paradigm to our actions in the world and takes as equivalent the concepts of paradigm, epistemological presupposition, premise, world view. The proposed model does not intend to be the only alternative to the solution of the problem of the MSE. According to Beer (1972, 1979), there are not right or wrong models, but more useful or less useful models. We hope that the proposed model would be useful to give some light to the complexity inherent to the problems of the MSE, and bring up for discussion relevant aspects related to the specific support policies of this kind of company.

This work also aimed to show the power of systems thinking, mainly when applied as a complementary study to the scientific research method. The complementary accomplishment of the systemic approach to the scientific research method has its advantages in several aspects. The scientific research depends on the restriction of the scope of

Table 2 Answers to twelve boundary questions in the "ought" mode

1. Who ought to be the client (beneficiary) of the system S to be projected or improved?
   The MSE should be the first benefited by the policies, which would take into account their nature and their specific needs. The community should also be seen as an indirect beneficiary, in consequence of the prosperity of the MSE.
2. What ought to be the purpose of the S system, i. e., which goals should the system S be capable of reaching in order to serve the client?
   The main purpose should be the sustainable development of the MSE aligned to the local development of the cities.
3. What ought to be the measure of success (or improvement) of the system S?
   The means of success should be based on indicators that directly measure the development of the MSE. Indirect indicators, as the mortality of the MSE, should not be used as a measure by excellence.
4. Who ought to be the decision-maker, i. e., who should have the power to change the means of improvement of the S system?
   The public power in collaboration with the support entities.
5. Which components (resources and restrictions) of the system S ought to be controlled by the decision-maker?
   Conditions as the financial resources, technological support, legislation and infrastructure, should be more controlled.
6. Which resources and conditions ought to be part of the environment of the system S, i. e., should not be controlled by the decision-maker?
   The decision-maker should not interfere in the free market competition, practicing stock market or conceding privileges to sectors or company groups.
7. Who ought to be involved as a designer of the system S?
   A work as a group of the public power, the support entities and even the research and educational institutions.
8. What kind of expertise ought to happen in the system S, i. e., who ought to be considered as an "expert" and what should be his/her role?
   A support system to the MSE should cover aspects as credit, management support, technological development, exportation incentive, technological innovation and professional qualification.
9. Who ought to be assumed to be a guarantor of the system S, i. e., where should the designer look for the guarantee that the system S would be successfully implemented, concerning the measure of success (or improvement) of the system S?
   A guaranty of success is certainly placed in the integration of the involved actors: public power, support entities, entrepreneurs.
10. Who ought to be among the witnesses representing the concerns of the people who will be or should be affected by the system S? In other words, who among the affected ones should be involved?
    The MSE interests need to be represented, and also the community that is directly and indirectly affected by the companies' actions. The companies' interests can be represented by the support entities. The support entities need, however, to better represent these interests. The MSE should participate in the activities of the support entities as active agents, and practice their citizenship right before the public power, involving themselves in the decisions.
11. In what degree and how ought the chance of emancipation from the premises and promises of the involved ones be given to the affected ones?
    Policies that view the sustained development of the MSE should reduce the degree of interference of the arbitrary decisions of the public power in the companies. Ways of decreasing the impact of the environment inconstancy over the MSE should be investigated.
12. On what world views should the system S be based on, of the involved or the affected ones?
    The involved ones should search for a systemic view of the problem, which would take into account the sustained development of the MSE aligned with a strategy of local development.

investigation to a reduced number of variables that allow exploring the veracity of the facts. The systems' thinking, however, allows enlarging the scope to a virtually unlimited scope that provides meaning to the research results. First of all, the systemic model is

useful, then, to describe the complex set of conditions in which the research results are observed. Secondly, when describing those conditions, the systemic approach brings a critical discernment to the interpretation of the research results, avoiding the isolation of factors from its context, what could inadvisably occur under the reductionist view. Finally, when looking into a wider context, the systems thinking reveals its exploratory feature, indicating new directions and interest focuses that could be the aim of more rigorous future investigations through the scientific method.

Concerning the investigated MSE, we could coordinate aspects of the complex reality of which those companies are part through the accomplishment of the systems thinking, emphasizing the idea that disintegrated support policies and isolated efforts from the support entities are not enough to improve the conditions that affect the development of those companies. The bureaucratic action of the public power on one side and the limitations of coordination by the support entities on the other side can explain the lack of cohesion of the system, in which the companies seem to have chosen, or have been conducted to a relative isolation. The disintegration also appears in the obvious lack of representation of the MSE interests before the public power. Besides, the lack of an intelligence system that is capable of establishing a long term strategic planning leaves the MSE vulnerable to the rigidity of inconstancies of the globalized environment. This lack of view of the future risks the companies' survival because the changes are unexpectedly presented, compromising the ability of adaptation of the system to changes.

A systemic effort to improve the conditions of the development of the MSE is a synonym of a higher common objective, which does not consider only the MSE specific interests, but also recognizes their particular needs within the wider context of their local community. The answer to this could be, as mentioned and observed in the examples before, a better coordination of the agents' action, including the public power, the support entities, the educational institutions and the entrepreneurs. In summary, the answer should be a strategy of a sustainable development of the MSE aligned to policies of local development assisted by the public power and coordinated by the action of the support entities.

References

Beer S (1972) Brain of the firm. Allen Lane, Londres

Beer S (1979) The heart of enterprise. Wiley, Chichester

Beer S (1985) Diagnosing the system for organizations. Wiley, Chichester

Beltrán AC, Cezarino LO (2005) Mudança Organizacional Sob o Enfoque Sistêmico. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Bertalanffy L (1968) General system theory. Foundations, development, applications. George Braziller, New York

Bertholo P, Camargo SHCRV (2005) A Contabilidade Integrada e os Sistemas de Informações para fins gerenciais. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Camargo SHCRV, Almeida CD, Farah OE, Martinelli DP (2005) A Importância da Visão Sistêmica para Elaboração das Estratégias Empresariais: uma pesquisa exploratória na região de Ribeirão Preto-SP. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Cezarino LO, Liboni L, Martinelli DP (2005) Metodologia SSM e sua aplicação na intervenção organizacional em uma empresa de propaganda. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Checkland PB (1981) Systems thinking, systems practice. Wiley, Chichester

Checkland P, Scholes J (1994) La Metodología de los Sistemas Suaves de Acción. Megabyte

Descartes R (1998) The world and other writings. In: Gaukroger S (ed) Cambridge University Press, Cambridge, UK

Donaires OS (2003) Aplicação de Abordagens Sistêmico-Evolutivas ao Problema do Planejamento e Controle de Múltiplos Projetos Concorrentes num Departamento de Desenvolvimento de uma Empresa Brasileira. Monografia de Conclusão do Curso de MBA Especialização em Administração. Ribeirão Preto, FUNDACE-FEARP/USP

Donaires OS (2005) Uma Abordagem Sistêmica Crítica à Implantação de um Processo de Desenvolvimento de Software. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Espejo R, Harnden R (1989) The VSM revisited in viable system model: interpretations and applications of Stafford Beer's (eds.), Wiley

Ghisi FA (2005) Visão Sistêmica das Relações Interorganizacionais: Uma Análise das Redes de Empresas. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Machado Neto AJ, Monteiro F, Giraldi JME (2005) O Modelo de Sistemas Viáveis—VSM: proposta para sua aplicação em uma instituição municipal de ensino superior. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Martinelli DP (1995) A Evolução da Teoria da Administração e a Hierarquização de Sistemas. Tese de Doutorado. São Paulo, FEA-USP

Martinelli DP, Ventura CAA (2006) Visão Sistêmica e Administração: Conceitos Metodologias e Aplicações. Saraiva, São Paulo

Narvarte PA (2001) El Modelo del Sistema Viable—MSV: experiencias de su aplicación en Chile. Proyecto Cerebro Colectivo del IAS, Santiago

Pinheiro MG, Cezarino LO, Figueiredo LR, Martinelli DP (2005) A Soft Systems Methodology (SSM) Aplicada A Um Projeto De Redução Da Infoexclusão: A Experiência De Uma Universidade Brasileira. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Ulrich W (1983) Critical heuristics of social planning: a new approach to practical philosophy. Bern: Haupt. Reprint edition, Chichester: Wiley, 1994

Ulrich W (2000) Reflective practice in the civil society: the contribution of critically systemic thinking. Reflect Pract 1(2):247–268

Ulrich W (2002) Critical systems heuristics. In: Daellenbach HG, Flood RL (eds) The informed student guide to management science. Thomson Learning, London, p 72s

Ulrich H, Krieg W (1972) Das St. Gallen Management-Modell. 1. ed. 1972, 3. ed. 1974. Bern, Haupt

Ulrich H, Probst GJB (1984) Self-organization and management of social systems. Springer, Berlin

Vasconcellos MHE (2005) Pensamento Sistêmico: uma epistemologia científica para uma ciência novo-paradigmática. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Ventura CAA, Cavalvanti MF, De Paula VAF (2005) A Abordagem Sistêmica da Teoria Pluralista das Relações Internacionais: O Estudo de Caso da União Européia. Anais do I Congresso Brasileiro de Sistemas. Ribeirão Preto, FEARP/USP

Wiener N (1948) Cybernetics. MIT Press, Cambridge, MA