"Application of Dynamic Systems Theory in the evaluation of an Integrated Business Excellence System"

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Abstract
This article utilises the principles of the Dynamic Systems in order to better contribute to the objective evaluation of an enterprise which implements a Business Excellence Model. The current practice of Business Excellence Models provides a "static" picture of business practices evaluation. Instead, the Dynamic Systems define the interaction of a system variables (as criteria, causes - results, etc.) giving the opportunity of more objective decision-making evaluation with regard to the areas for continuous improvement. The results of the above study will be imported in a computer program so that are recorded tendencies and are given initial prices of parameters of the system.

Keywords: Business Excellence models, Dynamic Systems, Total Quality Management, and Decision Making.

Introduction

Most Business Excellence Models attempt to analyze the impact of Total Quality Management (TQM) in the enterprises. As an example, it is the European Model of Business Excellence (EFQM), the American Model (Baldrige) and the Japanese one (Deming). However, all of the above models are used mainly in role of inspection, realizing an evaluation in a given time, as precisely the usual accountant practice. There are not many models which seek the dynamic influence of Total Quality (Leonard, 2003).

Realising the dynamic characteristics of Total Quality Management (TQM) in the enterprises it will be possible to evaluate and forecast current and potential advantages from the application of Total Quality Management.

The next paragraph provides a criticism of current methodology of Business Excellence Models that provide a static picture and less objective evaluation against the need for a more dynamic picture with more argued results. Afterwards, it is described the principles of Dynamic Systems and how they are used in the proposed system of Business Excellence (Mavroidis, 2005). Finally the results of the above study will be imported in a computer program so that are recorded tendencies and are given initial prices of parameters of the system.

Current Assessment Methodology

The European Model of Business Excellence and the other three main models (Baldrige, Deming, and Australian) are based on their own framework of Total Quality, which derives from the concept of the organisations they represent. These models use the self assessment as a tool of capturing business practices. They are not restricted in

products or services, like in the ISO 9000 case, but they rather co-evaluate other business activities. These models are similar to the scoring procedures and are differentiated mainly as to their evaluation method (Ghobadian and Woo, 1996).

These models are widely used all over the world by leading businesses and can be used as international evaluation criteria. They have considerably contributed in the development of the Total Quality, by making its philosophy a business practice. Garvin (1991) stated that the American Award (Baldrige) has been the main catalytic factor of change in the American business society. Juran (1994), among others has also been a supporter of the American Model. Blanas (2003, pp. 89-105) analyses the impact of major world quality awards and links them to the ISO 9000 approach to business excellence.

However, there is a different approach as to the views of the gurus of Quality, around the world. In his last interview Mr. Deming when asked on the benefits for businesses that apply the American Model, he replied:

«No, nothing could be worse. The evil effect of the Baldrige guidelines on American business can never be measured (Deming in Stevens 1994, pp. 21).

Additionally, Crosby (in Simms, 1991, p. 127) and Mc Adam & O'Neil (1999), Bester (2000), Gallear et al. (2000) have adopted the same critical line, also applying on the European Model of Business Excellence. Ghobadian and Woo (1996, p 16) state that the European Model has several disadvantages, such as lack of innovative evaluation, of strategic placement, of marketing cantered approach and R&D. However it has assisted the European businesses on a first basis in the implementation of the Total Quality principles.

In addition, Leonard (2003, p.654) argues that the European Model of Business Excellence is revised every 2 years, and consequently does not dispose of the extended analysis of the complex business environment, that in principle is dynamic.

The criteria for the European Model of Business Excellence connected to the "Policy and Strategy" do not focus on the effectiveness of the business strategy, or the amount of dynamics of the strategy planning, but instead evaluate how the Total Quality issues are incorporated in the strategic procedures. Porter (1996, p. 75) describes the matter as follows:

"The pursuit of operational effectiveness is seductive because it is concrete and actionable. Caught up in the race for operational effectiveness, many managers simply do not understand the need to have a strategy (Porter, 1996, p. 75)".

Additionally Van de Wiele (1995, page. 17) underlines that in large businesses, it is the representatives who decide when the self-evaluation will be conducted. Then, the middle ranged executives are activated in order to learn on self-evaluation and then implement it. The Total Quality has to dispose of an active sensor of data collection from the environment in order to provide fast and dynamic strategies to the businesses and should not have the passive role, reserved for it in the above-mentioned models. (Porter 1996, pp. 75).

The EFQM model has been criticized for its' self assessment mechanism, which provides a subjective score with wide fluctuation in the results, as stated in the bibliography by Porter and Tanner (1996), Siow et al. (2001), M. Liters and J.B. Yang (2003). The wide fluctuation in scores results from lack in experience of the

evaluators, from criteria complexity and from potential interactions and different scoring methods. The Multiple Attribute Decision Making (MADM) methodology, as a multi-criteria method, attempts to resolve the problem, without however taking into consideration the other dynamic parameters such as time, behaviour and culture as it is argued by Siow, Yang and Dale (2001).

Generally, a Total Quality system is described as a mental model and consequently it is highly possible not to provide with the desired results, in a more complex situation. The mental models are using the feedback theory, taking into consideration the current situation and interaction (Forrester, 1971). With respect to the complexity of the mental models in the Total Quality Management, Waldman (1994) suggested the application of the System Theory for implementing Total Quality. Bayer et al (2001) also suggested the use of dynamic models for Total Quality Management, so as to provide a more objective evaluation and long lasting decision-making. Leonard et al (2002) explained that Total Quality as a Dynamic System is complex, repetitive and is not adequately approached by the existing international Quality prizes.

According to the Theory of Dynamic Systems is possible to evaluate the relation (interdependence) of the variable of a system and to predict the performance with reference to time (Forrester, 1985). Through this methodology it is possible to have a better understanding of the self assessment process and to better value the business policy and strategy.

Agrawal (1999) in his doctorate thesis uses the Dynamic Systems Theory in order to form models for the Total Quality Management and to define a final index, as the total performance of applying Total Quality (TQM Index), based on the Indian automobile industry.

Consequently, as outlined by Leonard (2003, p. 655), the European Model of Business Excellence and other similar models have beneficial applications in businesses. However, it does not offer a complete approach on the business dynamics, and is thus becoming more a tool of a static image – business evaluation on a certain period of time, ignoring that the business itself is subject to dynamic changes and of course to dynamic pressures.

Proposed System of Business Excellence

Understanding the lack of models of Business Excellence – Total Quality, providing a static image and processing of Total Quality issues, the bibliography contains proposals concerning the creation of mechanisms, as models or systems, which represents a dynamic system of Business Excellence. Leonard and Mc Adam (2002) during their research based on the General Theory of Systems have reached the following conclusions that express the dynamics of Total Quality in businesses:

- Performance related to time,
- Repeated behaviours,
- Business Culture

Respectively, Mavroidis (2005) proposes a system of Business Excellence taking into consideration the above-mentioned issues and comprising of the following, as well:

- Evaluation criteria or parameters expressing the existing European Business practice of the time,
- Focus on the performance and the effectiveness of the approaches (the approaches of the respective results are not evaluated separately),
- Explanation of the interdependence between the criteria or the variables of the system (feedback loops),
- Open architecture.

The proposed system of Business Excellence provides a dynamic approach of the Total Quality issues, which, combined to the application of the Dynamic System theory, aims mainly at the consideration of a more objective plan for an organisation in order to provide constant improvement of the performance score.

It should be noted that currently a new **system** is proposed rather than a new **model** of Business Excellence. The system includes several Business Excellence models, initiatives on Quality, Quality Management systems etc. The interrelations and the influence of these models / initiatives are expressed by the performance and the effectiveness measurements, according to the above-mentioned theories (Figure 1):

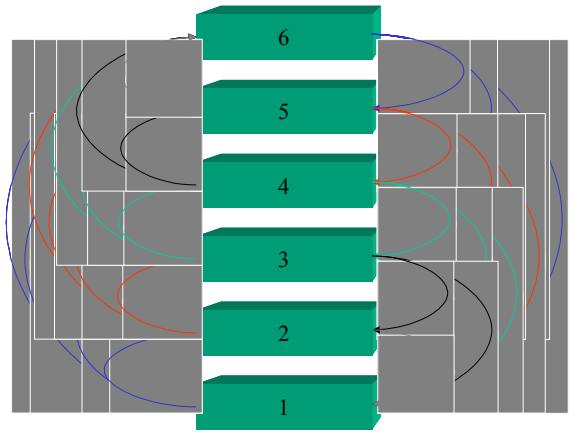

Figure 1: Cross-correlation of business areas of excellence formed as a Dynamic System (source: V. Mavroidis, University of Patras, 2004)

The proposed system is composed by well-structured levels or fields of excellence, with specific contents per level (as Quality initiatives or Business Excellence Models) which represent, up to a point, the meaning of the Quality, the Management & Organisation, and the Competitiveness- Innovation concepts in an organisation. The six levels are **independent** as to their approaches for Quality improvement, but they **depend on one another** for the total performance score and their consequent influence. The levels are 6, leaving the last level open towards the upper part (i.e. future levels). This approach is equivalent to the familiar level model of Telecommunications Networks (OSI-RM Model) that applies for computer networks and offers a clear description, a modular development and easy future development-enlargement. This system proposes a dynamic evaluation of the business performance, taking into consideration time, culture and business differences. Blanas (2003, pp. 137-191) analyses the link between Information Systems and Total Quality and makes visible the contribution of developing and managing an Information System to a respective Business Excellence System.

The proposed System is not a congregation of initiative models, nor a new model. The concept "system" is **characterized** by the dependence of

the levels (as to their influence) and by the concept already explained.

The proposed system is **dynamic** as to:

- The integration of current and potential tendencies and initiatives,
- The time-relation of "self assessments" of itself or of other levels,
- The relation with the business cultures of the respective geographical areas

The levels should follow the changes occurring dynamically in the models (publications or new models) and refer to the requirements deriving from the current market trends and the differentiation requirements, always focusing on the Geek market (combined with the European directions). These levels of excellence (Mavroidis, 2005) comprise the following areas:

- Level 1,"Organising and Managing Quality Management Systems" as refers to the international standards ISO 9001 and ISO 9004 (latest edition).
- Level 2, "Organising and Managing Sector specific and advanced (Quality) Management Systems" as refers to the international standards ISO 14001, ISO 22000 or other documented national initiatives.
- Level 3,"Managing and Supporting Clusters or Networked Enterprises",
- Level 4,"Managing Human Resources", either through a recognized standard or a documented national practice (such as the Investors in People initiative),
- Level 5,"Managing Advanced TQM Tools or Business Excellence Models", such as the EFQM Model or other national or sector specific initiatives or other recognized TQM initiatives such as 6 sigma where appropriate,
- Level 6, "Managing and supporting Innovation", as it is appreciated by national or European means of evaluation.

Additionally, the proposed **System** is open as to:

- The number of levels upwards (ie.7,8..) – dynamic differentiation,
- The actions for new models implementing specific levels (ie. potential new national model for a quality system in super markets or a new model on level 5 for very small businesses)
- The methodologies for restituting and processing data deriving from internal and external self assessments.

Review of the Theory of Dynamic Systems

The Dynamic Systems Theory explains the behavior of a complex, dynamic, social, technical, economic and political system (Social, Technological, Economic and Political Systems: S-T-E-P) for improved decision-making. Its roots go back 35 years, approximately, at the Industrial Dynamics' where Forrester (1971) explained the problems deriving from the industrial applications, such as unstable production and labor, unstable business development and market share. This theory expanded in other fields of interest, such as the management of a research and development project, the urban development, the management of energy resources and the chaos theory. The name "Industrial Dynamics" soon became Theory of Dynamic Systems.

The Dynamic Systems express the interactions of a system's variables and predict their influence in a certain period of time (Forrester, 1985). The application of Dynamic Systems is a modern tool in the decision-making procedure (Dangerfield, 1979). In the area of Total Quality Management (TQM) the application of the Dynamic Systems theory has been extensively studied in the bibliography. The Total Quality Management is described as a contemplative model and thus does not have a predictable behavior. Consequently, the application of system theories of the dynamic systems is imposed, as described in the bibliography by Forrester, 1971, Waldman, 1994, Bauer et al, 2001, Leonard et al, 2002. According to the latter, a Dynamic System is defined in relation to time, culture and repeated behavior.

The Dynamic Systems do not aim at the system; it rather aims at the problem (Forrester, 1985). The problems recognised under the prism of Dynamic Systems have at least two things in common: Firstly, they are dynamic, meaning they contain variables that change in time, in periodically repeated behaviors and in complex changes (Bauer et al, 2001). The "time" factor includes long-term development, current changes and predictable future directions. The factor "repeated behaviors" includes the non-linear behaviors either with positive or negative influence. The factor "complex changes" goes beyond the concept of cause and effect and includes phenomena that do not follow the predictable development in time. For instance, local unemployment, tax raises, management of life quality could delay the construction of a building, the development of an economy, etc. The correct definition of the problem is the first step in the Dynamic Systems Theory (Richardson and Pugh, 1981).

Secondly, the problems include the concept of feedback, as the servo-mechanic systems in engines and in human systems (Goodman, 1983). The Dynamic Systems focus on the structure and behavior of interconnected feedback. The re-alimentation diagrams demonstrate a real system where the arrow is showing to the influence's direction, and the marking (+) or (-) is showing the influence type, i.e. positive or negative influence, or no influence if there is no marking. The re-alimentations with a positive influence are usually human systems, as opposed to the servo-mechanic systems.

The Dynamic Systems have a "holistic" approach, rather than an entry-exit approach or a cause-effect one. According to this approach, the changes occurring in a space or in a sub-total of the system influence the sub-system itself as well as the rest of the sub-totals, as shown in the diagram below:

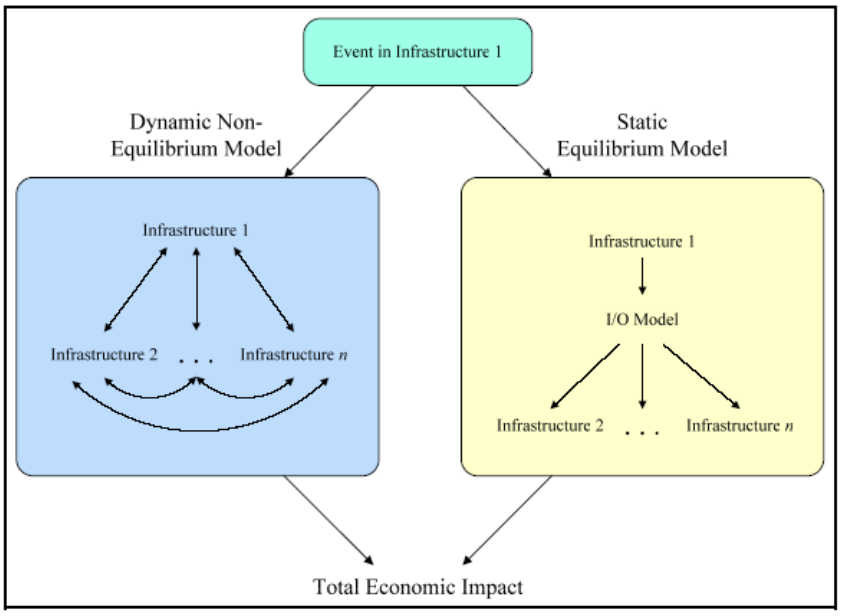

Figure 2: Dynamic Systems approach against Input / Output (I/O)

The modelling of Dynamic Systems contains five types of equations (Forrester, 1985):

- Level or Accumulation,
- Rate or Policy Variable,
- Auxiliary,
- Constant,
- Initial Value conditions, where

Level or Accumulation: Current rate of the variable, deriving from the inflow-outflow difference on a certain period of time (calculated on a distinct time). An example of this would be the balance of an account, the balance of plant production, the number of personnel.

Rate or Policy Variable: Instant flow that raises or diminishes the variables' rates (i.e. the levels). The rates demonstrate the flow movement, whereas the levels show the result as the system's situation, changed due to this movement. In the natural systems the rates follow the rules of nature. In the other systems, the rates reflect the strategic policies that influence personal choices.

Auxiliary: Auxiliary parameters for rate calculation. Rates and auxiliaries are based on certain constants, unchangeable in the time when the Dynamic Systems is studied. Vij (1990) provides the Dynamic Systems with one additional parameter, the "delay".

Concerning the Dynamic Systems model-making, Roberts (1978) and Spencer (1966) propose the following steps:

1) Definition of the problems to addressed and of the objectives to be reached,
2) System description with re-alimentation diagrams (causal loop / influence diagram),
3) Development of DYNAMO equations.
4) Collection of initial value conditions, either from historical sources, or by interviewing experts who are familiar with the system under evaluation.
5) Ratification of the model for developing its credibility.

6) Simulation of the model in order to control the policy and the action that will lead into achieving the defined objectives.

Application of the Theory of Dynamic Systems to the proposed system of Business Excellence

The theory of Dynamic Systems can be applied in the proposed system of Business Excellence (Mavroidis 2005) which is already taking into consideration the parameters or the elements presenting a certain dynamic.

The Dynamic Systems are used in this paper in order to:

1. Define the final balanced performance of Business Excellence of an organization in relation to **time** evaluation. As opposed to the current practice, where a business is evaluated on a precise moment of time, the proposed system would calculate through an adequate mathematical equation the performances of previous evaluations of the same variable.
2. Provide documentation for a system "dynamic" through a) definition of the distinct levels expressing National and European knowledgeable initiatives, b) a gravity coefficient of the distinct levels that reflect the business **particularities** of the country applied in the system of Business Excellence. _
3. Outline the **interactions** of the system variables, with ultimate goal to find the influences, through the equations DYNAMO of the Dynamic Systems. As a result it is possible to calculate which variables are influencing positively, negatively, or neutrally the rest of them and to form a basis for decision-making, as to which improvement actions should be put on in the first place as regards the organisation's objectives. Additionally, it is expected that a more objective evaluation of the business will gain ground.
4. **Integrate per variable** (i.e. Level or question etc) of the concept of cause and effect calculating. Consequently the evaluation of the variable performance and effectiveness is performed per question or level, going beyond the "concept" of cause-and effect, (McCabe, 2000)

Dynamic Systems-Time

As stated above, the final balanced return of Business Excellence of a organisation takes into consideration the final returns of Business Excellence of the previous years. Consequently, an adequate mathematic formula is needed in order to calculate the quest, as:

Final Output or Score (2006) = A (2006) = fx [A(2005), A(2004), A(2003), …], where fx is a suitable mathematic equation.

The current paper does not aim at defining the appropriate equation through a comparative evaluation of different assumptions. Perhaps, this could be the object of a future study. It is **a business decision, or generally a collective business decision** that will define which is the best assumption of mathematic equation that could best express the dynamic character of Business Excellence.

Following certain assumptions are given to utilise the suitable mathematic equation. For this aim in each assumption is given numeration.

Assumption 1: f1

This simpler assumption takes into consideration the current and the previous years output with the same weight.

The more suitable mathematic equation of first assumption is the "Mean of" outputs.

Assumption 2: f2

The next assumption takes into consideration the positive or negative tendencies of current and the previous years outputs.

Assumption 3: f3

The next assumption takes into consideration their same objectives of enterprise of current and the previous years outputs.

Assumption 4: f4

The next assumption takes into consideration exterior or better comparatively sector-based objectives of current and the previous years outputs.

Assumption 5: f5

The next assumption takes into consideration the positive or negative tendencies and/or the same objectives of enterprise and/or exterior or better comparatively sector-based objectives of current and the previous year's outputs.

It is also estimated that all the possible assumptions could be applied, depending on the maturity of the Business Excellence systems, of the business world as a whole.

Dynamic Systems- Culture

Another important parameter of a Dynamic System relates to the business culture. For this purpose, the system under analysis is taking into consideration the current and future knowledgeable national and European initiatives, balanced on the basis of the business particularities of the country's culture.

This balancing is initially defined empirically taking into account the current balanced point of view. Through simulation it is possible to calculate the best balancing.

Dynamic Systems- Interactions of variables

The "variable" is defined as every parameter with a metric value in the proposed system. Consequently, the variables are the "levels of Business Excellence" or the distinct level questions.
On the basis of the above, as

Total Return of a business in time (t) is defined as:

$$Final\ Score\ (t) = \sum [An(t) * \sigma v], \qquad where\ n = 1\ to\ 6$$

An(t): Output of level n (1 to 6) in the real time of assessment (t),
σn: Dynamic Factor of level that is fixed by the enterprising community (from external environment of enterprise with output from 0-1, and with sum [σn] = 1. The σn is fixed every so many years that

roughly the corresponding publications of individual systems of levels.

Output of level n *= An(t) = f1(An(t-tx))+f2(A(6-n)(t-tx)*R(6-n)n)*

Where f1: a function of the evaluations of the same level in older evaluations, at the same number as "x" that could be the AVERAGE or another function that shows the tendencies and the level of self organizing, etc.

f2: respectively a function of evaluations of the remaining levels of the "system" at the respective time.

As RATE, R(6-n)n is defined as the ratio or the influence (positive of negative) of the variable scored (i.e. n) with the other variables. This ratio is defined as R(6-n)n with n ≠ (6-n) it has a rate varying from −1 to +1.. Inversely, Rn(6-n) concerns the influence of level n on level (6-n).

The ratio Rn(6-n) or generally, Rxy shows the relation between 2 "variables" or 'agents' of a system. More specifically is shows the influence or the relation of variable X to variable Y. The variables could be either levels, or level questions, or question groups (i.e. Criteria). Consequently the ration Rxy is defined as follows:

Rxy = If we CHANGE (improve [+], or decrease [-]) performance and effectiveness of variable X, how will it affect the effectiveness of variable Y?

These relations can be defined, either by a) external factors for example questionnaire processing for businesses, proving that level X influences level Y, and have the demanded formula derived from this procedure, or b) by internal factors for the business itself, where using simulation on PC will lead to the best price.

Initially, the relation Rxy acquires a rate of empirical estimation. Then, the two previously described methods result in a more documented rate. In the framework of a complex theory this relation is variable and is affected by the system itself as self-organizing, fitness.

Consequently in the effort of improving a level, it is not only sufficient to improve the effectiveness of the level itself (in other times) or the performance of the other levels, but also the influence (through procedures) of the feedback procedure (Brodback, 2002). For example, education, change of culture, management changes, related to the implementation of level 1 could seriously affect level 6.

Also:

$$R(6-n)n = \sum [\sum [R(6-n)\kappa * \sigma\kappa]]$$

Where

- n declares the evaluated level,
- (6-n) declares the remainder levels,
- σκ declares the gravity of question κ,
- κ declares the particular question per level

EXAMPLE:

Level 1 has **30** questions in total, so:

K= 30.

Question 1.1, has σ1.1 = 10/100
Question 1.2, has σ1.2 = 20/100
Question 1.3, has σ1.3 = 1/100
…
…
…
Question 1.30, has σ1.30 = 8/100

$$\Sigma\ R_{(6-n)\kappa} * \sigma_{\kappa} = [R_{2(1.1)} * \sigma_{1.1} + R_{2(1.2)} * \sigma_{1.2} + \ldots R_{2(1.30)} * \sigma_{1.30}]$$

$$\Sigma\ [\Sigma\ [R_{\kappa(6-n)} * \sigma_{\kappa}]] = [R_{(1.1)2} * \sigma_{\kappa 1.1} + R_{(1.2)2} * \sigma_{\kappa 1.2} + \ldots R_{(1.30)2} * \sigma_{\kappa 1.30}]$$

$$+$$

$$[R_{(1.1)3} * \sigma_{\kappa 1.1} + R_{(1.2)3} * \sigma_{\kappa 1.2} + \ldots R_{(1.30)3} * \sigma_{\kappa 1.30}]$$

$$+$$

$$[R_{(1.1)4} * \sigma_{\kappa 1.1} + R_{(1.2)4} * \sigma_{\kappa 1.2} + \ldots R_{(1.30)4} * \sigma_{\kappa 1.30}]$$

$$+$$

$$[R_{(1.1)5} * \sigma_{\kappa 1.1} + R_{(1.2)5} * \sigma_{\kappa 1.2} + \ldots R_{(1.30)5} * \sigma_{\kappa 1.30}]$$

$$+$$

$$[R_{(1.1)6} * \sigma_{\kappa 1.1} + R_{(1.2)6} * \sigma_{\kappa 1.2} + \ldots R_{(1.30)6} * \sigma_{\kappa 1.30}]$$

Dynamic Systems- Variable integration

Every variable (question or level) is evaluated for it's performance and effectiveness, taking into account the approaches and the results.

For every level we define a set of questions, evaluated in a 5-choice scale:

Assessment Criteria	**Definition**	**Score**
World-class	…	1,0
Award Winners	…	0.75
Improvers	…	0.50
Drifters	…	0.25
Uncommitted	…	0

(Source: Siow et al, 2001)

Each question has a weigh factor in relation to the level of assessment.

SIMULATION & PARAMETER CALCULATION

The features of the Dynamic System studied in the previous paragraphs, will be implemented in a Business Excellence model, bearing a structure as described in the relevant published article by Mavroidis (2005).

For publishing reasons, the simulation will be described in a future article. In the current publication we will provide the initial rate to the relation Rxy and through simulation we will analyse the tendancies and ratify the dynamic system.

Summarizing, the proposed system of Business Excellence (Mavroidis, technical Chronice, Technical Chamber of Greece 2005) is modelised according to the principles of the Dynamic Systems, aiming at:

1. Defining the final balanced result of the Business Excellence of a organisation in relation to **time** evaluation. Contrary to the current practice, where a organisation is evaluated on a precise moment of time, the proposed system is calculating through an adequate mathematic equation the results of the previous evaluations of the same variables.
2. Documenting the "dynamics" of the system, through: a) defining the distinct levels expressing the knowledgeable National and European initiatives, b) a gravity coefficient of the distinct levels representing the business **particularities** of the country where the Business Excellence system is applied.
3. Outlining the **interactions** of the system variables, with ultimate goal to find the influences, through the equations DYNAMO of the Dynamic Systems. As a result, it can be calculated which variables are influencing positively, negatively, or neutrally the rest of the variables, and form the basis for decision-making, as to which action should be routed in the first place as regards to the achievements of the organisation's objectives.
4. **Integrating per variable** (i.e. level or question etc) the concept of calculating the causes and the effects. Consequently, the evaluation of the performance and the effectiveness is done per question or per level of the variable, going beyond the "concept" of cause and effect, (McCabe, 2000).

References

Agrawal, S.K. (1999), "Business Excellence model in Indian context: a select study", unpublished PhD thesis, Indian Institute of Technology Delhi, India.

Ahmed A.M., (2001), "Virtual integrated performance measurement", *International Journal of Quality and Reliability Management*, Vol. 19 No.4, pp 414-445.

Bauer, A., Reiner, G. and Schomschule, R. (2001), "Organizational and quality systems development: an analysis via a dynamic simulation model", Journal of Total Quality Management, Vol. 11 No. 4, pp. 410-16.

Bester, Y. (2000), "Analyzing the quality strategy for the 2000s", *Proceedings of the ASQC Quality Congress, Milwaukee, USA*, pp. 460-466

Blanas, G. (2003), "Networking Total Quality", Book, Pataki publishments, pp.89-105, pp.137-191.

Brodbeck, P. (2002): "Complexity theory and organization procedure design", *Business Process Management Journal (Emerald)* Vol 8. No.4.

Forrester, J.W. (1971), World Dynamics, MIT Press, Cambridge, MA, p. 13.

Forrester, J.W. (1985), Industrial Dynamics, MIT Press, Cambridge, MA.

Gallear, D., Ghobadian, A., Liu, J. and Woo, H. (2000), ªQuality and business process synergy: key strategies promoting longevity°, *International Journal of Manufacturing Technology and Management*, Vol. 2 No. 7, pp. 983-93.

Garvin, D.A. (1991), "How the Baldrige Award really works", *Harvard Business Review*, November-December, pp. 80-93.

Ghobadian A. and Woo, H.S. (1996), "Characteristics, benefits and shortcomings of four major quality awards", *International Journal of Quality and Reliability Management*, Vol. 13 No.2, pp10-14.

Goodman, M.R. (1983), Study Notes in System Dynamics, Wright Allen Press, Cambridge, MA.

Juran, J. (1994), "Juran on the Reward of Awards", *European Quality*, EQA Edition, p.48.

Khanna V.K., et al (2003), "Managing the transition phases in the TQM journey: a system dynamics approach", - *International Journal of Quality and Reliability Management*, Vol. 21 No.5, pp 518-544.

Leonard D., McAdam R. et. al. (2002), "A grounded multi-model framework for TQM dynamics", *International Journal of Quality and Reliability Management*, Vol. 19 No.6, pp 710-736.

Leonard, D. (2003): "An evaluative framework for TQM dynamics in organizations", *International Journal of Operations and Production Management* (Emerald) Vol 23, No. 6.

Leonard, D., McAdam, R. and Reid, R. (2002), "A grounded multi-model framework for TQM dynamics", International Journal of Quality and Reliability Management, Vol. 19 No. 6, pp. 710-36.

M. Liters' and J.B. Yang (2003), "A decision model for self assessment of business process based on the EFQM excellence model", International Journal of Quality and Reliability Management, Vol. 20, No. 2, pp164-188.

McAdam, R. and O'Neill, E. (1999), "Taking a critical perspective to the European Business Excellence Model using a balanced scorecard approach: a case study in the service sector", *Journal of Managing Service Quality*, Vol. 9 No. 3, pp. 191-8.

Porter, L.J and Tanner, S.J. (1996), *Assessing Business Excellence: A Guide to Self-assessment*, Butterworth-Heinemann, Oxford.

Porter, M.E. (1996), "What is strategy? ", *Harvard Business Review*, November-December, pp. 61-78.

Richardson, G.P and Pugh, A.L. III (1981), Introduction to System Dynamics Modeling with Dynamics Modeling with Dynamo, MIT Press, Cambridge, MA.
Roberts, E.B. (1978), Managerial Applications of System Dynamics, MIT Press, Cambridge, MA.
Simms, A.C., Bowles, J., Crosby, P.B., Gale, B.T., Garvin, D., Hammond, J., Reimann, C.W., Edwards Deming, W., Crawford-Mason, C., Clausing, D., Galvin, R.W., Kearns-Hockman, K., Pifer, P., Cooper, G.E., Leach, K.E., McKeown, K., Peck, D., Shiba, S., Peterson, D.E., Irwin, B.M., Rocjard, M.E and d'Arbelogg, A. (1991), ªDoes the Baldrige Award really work? º, *Harvard Business Review*, January-February, pp. 126-47
Siow, C.H.R., Yang, J.B and Dale, B.G. (2001), ªA new modeling framework for organisational self-assessment: development and applicationº, *Quality Management Journal*, Vol. 8 No. 4, pp. 34-47.
Spencer, R.S. (1966), "Modeling strategies for corporate growth", paper presented at the Conference of American Association for the Advancement of Science, Washington, DC.
Stevens, T. (1994), "Dr. Deming: management today does not know what its job is", *Industry Week*, January, pp 21-8.
Van der Wiele, T., Dale, B., Williams, R., Kolb, F., Moreno Luzon, D., Schmidt, A. and Wallace, M. (1995), "State-of-the-art study on self-assessment", *The TQM Magazine*, Vol. 7 No. 4, pp. 13-17.
Vij, A.K. (1990), "Energy policy modeling and analysis for the Indian economy", unpublished PhD thesis, Indian Institute of Technology, New Delhi.
Waldman, D.A. (1994), "The contributions of total quality management to a theory of work performance", Academy of Management Review, Vol. 19, pp. 510-36.
Mavroidis, V. (2005), "Proposal for a Completed System of Business Excellence", *Technical Chamber Greece, Technical Time, Bimonthly Publication Sept-Oct 2005*.

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