The evaluation of a political system, using the Markov model, with sustainability and safety as reverse processes.

Lepage, A.

Abstract: ***Which evaluation model could measure political conditions, as a real state describing the immediate future, with the combined effect of a sustainable advance process and a safety reverse one?***

The research is based on the assumption that the global evaluation of a political project follows the model which we largely validated on complex systems, such as energy production plants and customer services, for the respective measurement of availability and global satisfaction. In fact, the Markov model, as validated by our laboratory's practical application of it in commercial companies, enables us to calculate the state of availability (or global satisfaction) as the effect of two cross reverse processes: failure development (punctual dissatisfaction) and improving team performance (service quality improvement team). In extension, a validation framework, of political system efficiency measurement, is proposed, with aggregation of micro-processs measurements and a multi-criteria approach, combined with a measurement of safety abstracted from the United Nations Conference of Environment and Development.

Index Terms: ***global evaluation, political system, sustainability, safety, reverse processes, Markov model, political efficiency***

1. THE EVALUATION OF A COMPLEX SYSTEM

Many examples of discordance between politicians and the electorate can be found. The development of policy involves ambitious projects, which are able to motivate citizens and suggest a pleasant and more economically secure future, but politicians have to question themselves about the possibility of proposing projects which take into account people's perceptions of their daily lives within the many processes which constitute a complex social structure.

The political system, consisting of the citizens and politicians within it and the institutions and committees who drive the organisation of it, is a complex one. We understand that it has to be evaluated as an entity which is able to preview the immediate future, with sustainability for people and, conversely, safety in the necessary, difficult actions which assure its progression.

Our laboratory validated Markov-based models to describe such complex systems with a minimum of two reverse processes in two distinct cases: first, in power plants (which is not discussed here) and, secondly, in the measurement of global satisfaction of customers participating in the activities at a Leisure Park.

Citizens' perception of political policy is a global satisfaction which allows us to exploit the similarities between the evaluation of a political system and that of global customer satisfaction, basing our research on the assumption that the evaluation of a political system follows the Markov model, with two reverse processes: one orientated towards safety and control, which makes for citizen dissatisfaction, and a second one for sustainability which makes for citizen satisfaction.

Our purpose is, first, to present the elaboration of the complex global evaluation from two reverse processes and, secondly, to discuss the relevance of the approach, with separate examples of the perception of a detailed failure, producing punctual dissatisfaction, and the global perception of satisfaction, made up of many adjustments to punctual satisfactions and dissatisfactions.

2. PREVIOUS EXPERIENCE OF THE MEASUREMENT OF CUSTOMER SATISFACTION, ENHANCED BY THE USE OF MARKOV SYSTEMS.

2.1. Introduction to complex system dynamics

Customer Service managers need a model for the dynamic evolution of customer satisfaction (discussed in the conference report of the "National Conference of Quality Research", France, and by Cronin and Taylor (1). It has been undertaken by many companies using an empirical method which applies the same short questionnaire, of a maximum of ten questions, during a period of time, to customers who are using a service which is in slow evolution. The

detailed comparison of the results is made qualitatively by reading the customers' answers and the dynamic analysis is carried out by confronting the total result of customer satisfaction calculated at the time of measurement. The qualitative analysis is established, by discussion between managers of the customer service, experts in statistics and quality managers, without any attempt at modelling. The follow-up of the evolution remains problematical, and an innovation is needed, such as, for example, the dynamic Chronem method, which was proposed by P. Maillard of the French Institute for Research and Development of Quality. The method compares, during a period of time, the various states of customer satisfaction, by using 'snap-shots' of Factorial Analysis of Correspondences or Analyses in Principal Components, as described in the work of Herman Aguinis (2) and Cohen (3). Some authors came to consider communication and marketing approaches in customer satisfaction, such as Eiglier and Leangeard (4), and Parasuman, Zeithaml and Berry (5). However, these interesting proposals did not enable us to take into account the intensity of human effort, employed in the improvement of products and services, in order to improve customer satisfaction.

Therefore, we evolved the dynamic Qualisat method, which we deposited at INPI (6). The method proposes that, during a period of time, a comparison of customer satisfaction be made, measured with the usual tools that are available in the software for data analysis, with the level of effort and improvement of products and services as coefficients. We implemented this method at a large French leisure park and it allowed us to examine, every evening, the results of questioning a hundred people. The beginning of this theoretical approach, made on the site, was used to take concrete actions of correction when a drift in the level of customer satisfaction appeared. Indeed, at each sudden degradation of satisfaction, we deployed a 'rapid reaction force' of specialised teams, the very next morning. Conversely, if a gradual drift in degradation was observed, a steering committee, chaired by the person responsible for quality, was convened. This committee was charged with proposing solutions for the improvement in quality to the main board of management.

We were able to use, at the Leisure Park, the considerable body of data available to make a more scientific further study of the total satisfaction of the customers, as an up-to-date indicator of the efficacy of the management's strategy. We were also able to use the returns of 130 daily questionnaires, each containing 24 questions, which were applied by the hostesses at reception. One of the questions related to their personal perception of overall satisfaction which produced very varied and unreliable responses from the customers. It allowed us to make a comparison with the empirical calculation of this total satisfaction. It was easy to carry this out, using the large number of answers returned from the detailed, factual questions. This proved to be a consistent, reliable result, as was confirmed by later experiment. Analysing these statements, we postulated two hypothesises (H1 and H2) relating to the global satisfaction of customers:

H1) The perception of satisfaction does not follow a linear model.

H2) The quality of the products or services offered, as perceived by the customers, is not linear in relation to the efforts for improvement made by the teams involved in finding solutions (or service-maintenance).

Indeed, satisfaction is measured personally by the customer, at a linear level, by ticking his selection on a 1 to 5 supposed linear scale, for example. This drift appears even if a hostess poses the questions verbally and herself completes the questionnaire form for the customer. Incidentally, we cannot know if the perceived level 4, for example, is really the perception of level 2, in the mind of the customer. Some criticism can be levelled at the efforts made by the teams charged with finding solutions for the improvement of customer satisfaction with products and services. In particular, as the professional members work in a project design team, it is almost impossible for them to produce a linear result to their work -effectiveness, aptitude for collaboration, capacity for work, etc. – in relation to the number of team members. The difficulty in producing a linear result is related to their capacity for co-operation and the sharing of their own specialist knowledge, skills, and perceptions.

We can justify this assumption from the studies of Kano (7) which shows, for all products or services, that only 20% of the products and services, classified as "explicit expectations", that only 20% give a linear result. Therefore, our first hypothesis is already validated at 80%, on first examination. On second examination, the services configuration at the leisure park shows that the product or service functions do not figure in the 20% of the Kano study, in relation to the impact of the efforts to improve the services, made by the specialist teams. Indeed, we know from daily statistical data that the perception of service quality depends more on external, environmental factors than directly from the service improvement. However, later, the quality depends quasi directly on cumulative efforts of the improvement teams to offer better outcomes. So this validates to 100% our two hypothesises.

Customer satisfaction is directly linked with to how memorable the service received is

(Edvardson, Gustafsson, Enquist, (8)). Edvardson also demonstrates that the service empowers the customers to become part–time employees and to co–create functions of the product and services which give value. He also shows that customers form a favorable perception of their overall satisfaction with the product or service if they have had a particularly good experience in the small part of it. By the same token, poor experience in only a small part of the product or service has a great bearing on the formation of the overall perception of satisfaction of the customer.

An important conclusion from the “Assises Nationales de la Recherche en Qualité”, Versailles, France, In 1998 (11), was that the measurement of service quality is reliable in relative results comparing similar events, or in measuring small detailed topics of the same event, in the same conditions, and repeated many times. However, the absolute measurement of a global service at one given time is not reliable.

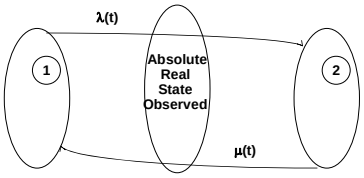
Even if these complementary conclusions from other researchers’ work confirms the validation of our two hypotheses, the measurement of global satisfaction has to be carried out by partial measurement of the simple, detailed elements which make up the complex global service.

The data obtained, and the observations made, at the leisure park, enabled us easily to elaborate two discoveries: 1 - We found that the evolution laws of the loss of total satisfaction generated by increasing levels of failure, revealed an decreasing exponential function curve; 2 - We found also that the return of satisfaction, that followed increasing levels of effort of re-design / re-organisation, revealed a logarithmic function curve.

Moreover, our analysis of the satisfaction measurements, using the criteria of the presence or absence of failure and the effort to re-design/re-organise, revealed the existence of two opposite processes acting simultaneously on total satisfaction: the first process Is the degradation of satisfaction arising from default and the second is the re-building of satisfaction by the improvement of re-design. The existence on the site of an engineering culture created conditions in which there was an incentive scheme to learn about reliability and availability of technical equipment. We should mention that one member of our research team, who had a education in engineering, had experience of working at a power plant. His specialty had been the improvement in reliability of technical plant and in the continuous measurement of the availability of this plant. Even though he had personal experience of the measurement of availability, using the Markov models, we were not concerned with Mechanics and preferred to present, directly, its application to the reliability and availability of services. The previous research supported our validation of our two hypotheses H1 and H2, and the establishment of our calculation of global satisfaction, using the measurement of discrete parts of the complex system of service, based on the Markov mathematical systems.

2.2. The two reverse processes of the Markov model, default and improvement

The Markov models were chosen to describe complex global satisfaction phenomena because of their ability to synthesise cross reverse dynamic processes. They have been tested, over a long period of time, in maintenance and technology, as described by R.D. Mauldin and M. Urbanski (9), V. Gupta, R.M. Murray and B. Hassibi (10). Here, they allow us to take into account the non-linearity of the failure of a product or service and the performance of re-design for their improvement, as well as the opposite and interactive nature of the two processes. That is, the degradation of a product or service and, conversely, their improvement, which make up the global satisfaction. It is based on the probable position in the time of a real situation between two extreme, ideal, theoretical situations relative to the number of basic team repairer-originators (elementary team members, carrying out routine re–design or repair). The principle of this model is shown in the following figure 1:



- **Global and theoretical initial state which could be ideal (1) :**
  - 100% satisfied equipment at reception test, qualification test
  - 100% satisfied general state at test,
  - Etc...
- **Global final theoretical state (2) :**
  - **Bad functionning situation**
  - **Equipment just at the rejected limit**
  - **Etc...**

Figure 1 general Markov model

The interest of the Markov Models is that they make the framework scientifically irreproachable by adopting the following definition of “satisfaction” (using the definition of “reliability” seen in Markov’s method) : "the probability of offering good responses to formulated needs of customers between the delivery time and the measurement time, noted R(t)". It should be remarked that the definition also means: "zero dissatisfaction of the customer, between the moment 0 and the moment T of analysis", which supposes a measuring instrument, from time 0,

and that we have the problem of a previously-established linearity. It should also be remarked that the definition of availability, which is included in Markov's method, is more accessible and could be written as follows: "The probability of being able to offer a solution to formulated needs of customers at the moment T, noted A(t)". This definition makes it possible to use a measuring instrument, conceived at the time of the wish to take a "snap-shot" of the situation, without being concerned with the existence of previous, or later, measurements. We will adopt this approach of "availability of satisfaction", A(t), because it is applicable even if the state of customer satisfaction, is not known before the "snap-shot" taken at the moment of measurement. It is especially applicable because it corresponds to the operational and practical methods of instinctively measurement of customer satisfaction, adopted by companies. However, while employing this method; most quality managers forget to establish questions about the existing states of satisfaction.

2.3. Approximation Method in satisfaction measurement

A simple and scientifically acceptable method of measurement consists in admitting that the natural degradation of satisfaction, $\lambda(t)$, in the absence of repair, follows a mathematical law close to "decreasing exponential", which offers approximate values. The same approximation can be made for the improvement ratio, $\mu(t)$:

- *$\lambda(t)$ = 1/Mean Time of Correct Operation (Between Failures), where MTBF is the commutative duration in hours of opening (service) or use (produced) between the delivery, after successful re-design, given 100% satisfaction, and the appearance of the first dissatisfied customer, that is, an objection to a failure in a clear and precise way.*
- *$\mu(t)$ = 1/Mean Time to Repair where MTR is the duration, in hours, between the beginning of the work of the re-design team and the moment of successful delivery of the solution for the product or service.*

It should be remarked that this approach is completely coherent with the results of the work of the National Conference of Research in Quality, Versailles, December 1997 (11), that is, the absolute total satisfaction of customers is not directly measurable, but is possibly calculable. Degradations or improvements in satisfaction can be measured effectively as a relative measurement. It is this approximative approach which will be used as often as possible, for its simplicity and ease of use the calculation of the availability of the solutions offered to the needs of customers, between two theoretical states, during the time A(t). It should be noted that there must be degradation/improvement histories in the companies because, if there is not, another calculation method based on zero initial information, must be employed. It is like making an "anticipated calculation" about the probable and total satisfaction of the customers, relative to the time passed in re-design which is allowed, under the conditions of the degradation of the product or service, as in the following mathematical model, shown in Figure 2 :

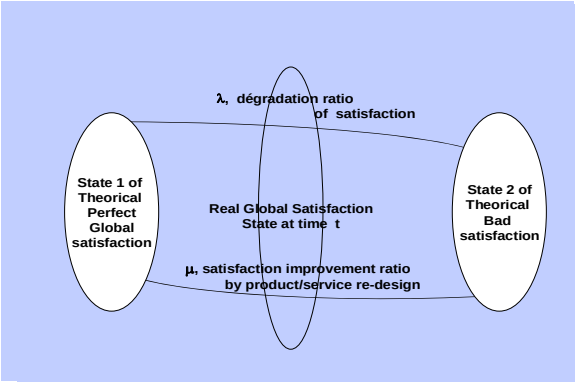


Figure 2: global satisfaction Markov model

The Laplace transformation method is used in the subsequent calculations, but they are not continued here. Significant curves, of the availability of satisfaction of customers obtained, can be seen in Figure 3.

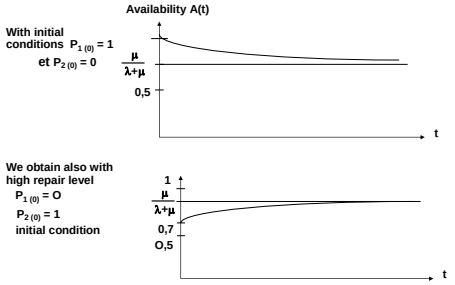


Figure 3: Satisfaction asymptotic curve at equilibrium

2.4. Validation of the model in companies

We compared the results of this method, based on the Markov Model, with the classical method, based on large-scale questionnaires, because it was easy to employ the two methods, concurrently, at the Leisure Park. The model was tested in two further companies, a Bank and a French Car manufacturer (not discussed here). In each case, the Markov Model had more consistency and reliability than in large-scale

classical questioning (A. Lepage, 2000 (12)). In conclusion, we can suggest the possible applications of these validations.

2.5. Conclusion of the validation

The application of the Markov Model at the Leisure Park, λ in % of failures, per hour of service (event) opening to customers (analysing histories of maintenance or instantaneous observation) and μ in % of cases making a successful repair per hour (a number of times where there was success divided per some times where one tried in less than one hour). It should be noted that, in this case, a successful repair achieved in 1h30, counts as zero. This model was employed on this site to improve the reliability of the measurements of satisfaction. The application of the Markov Model achieved a level of reliability of 98% in the measurement of global satisfaction whereas the use of the large-scale questionnaire method achieved around 62% reliability. The most important conclusion indicated by the validation is that the direct measurement of global satisfaction is complex and not reliable. It is better to calculate global satisfaction by using Markov systems on detailed failures and improvements (from small, reliable perceived parts of the processes, which are easily measured). On the other hand, the applications we have described in other companies showed that the effectiveness in the relation we described theoretically, between measured and perceived failure, the effort employed in improvement or repair and the calculation of global satisfaction with perceived global satisfaction. The application described here, was selected for the case of its experimental use, together with the large number of possible checks in the speed and ease of the analyses of degradation and repair. We should mention especially the speed of the effects of improvement by increasing the teams responsible for improving service, the "repair" teams. The measurements of λ and μ was very easy to carry out. They can be made on an impromptu basis, spontaneously, by the analyst, even when he does not have any history of the customer requirements, nor of repairs, which give a snap-shot of recent events. Thus the Markov Model is very adaptable because it can be appropriately employed in companies where there are relatively poorly developed methodologies in the statistical analysis of quality. The very satisfactory outcomes of the application of the model in the Bank and car manufacturing company can be consulted in the doctoral thesis of Alain Lepage (12), which shows the possibility of solving, in the car manufacture, the distortion between the lack of increase in customer's satisfaction and the delivery of a consequent, and expensive, improvement in the performance of the vehicle.

3. THE PROPOSITION OF THE USE OF THE MARKOV MODEL FOR THE EVALUATION OF POLITICAL SYSTEMS

3.1. Introduction of the Markov model

The application of the Markov system to the calculation of customer satisfaction explains the non-linearity of the perception of satisfaction, from the detailed default observation by faults, by the customer, which perhaps generates dissatisfaction, to the perception of global satisfaction with the service. This is itself combined with a complex series of particular dissatisfactions and satisfactions with the micro–processes of the daily ground. We propose to consider that, in the same way, citizens' satisfaction with a political system is not directly generated by particular points of satisfactions in the daily life of the people, but made relative to particular satisfactions and dissatisfactions with the daily political reality. From this, we have to elaborate the Markov system with its two reverse processes. We think that the process which comes immediately to mind, when we consider political development towards giving a better quality of life, is sustainability. In the same way, we think that the process which leads to the degradation of quality of life, is safety. This proposition is shown in the preview, Figure 4:

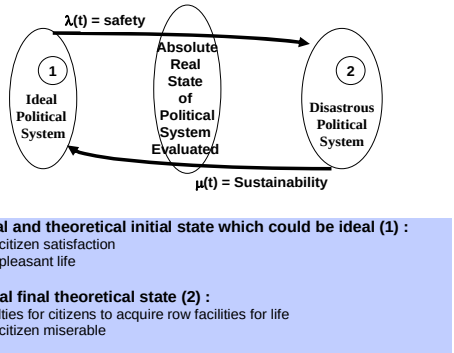


Figure 4: Markov model for political system's evaluation

3.2. The two reverse processes of sustainability and safety

The first process, of sustainability, is made up of many resources, supports and actions which offer citizens a better quality of life. However it has to be designed by the beneficiaries themselves, who are also the participants in the process in which the overall view of the shape of the future is proposed by the politicians. What we define as sustainability is the measure of the quality of the political system, as mentioned in the report on the United Nations Conference on Environment and Development (13 and 14). A

more detailed definition is postulated by H.N. Afgan and G.M. Carvalho (15): “the measure of the quality of our society is its ability to secure, and not compromise, the right of future generations to have a quality of life, at least equal to that of its own generation”. Sustainability is seen here as people’s self organisation driven by the desire to obtain the best quality of life, under constraints of financial feasibility and individual and collective safety. However, some authors view sustainability as a measure of quality (Gianpiero, Mayuari, Postar (16)) and others underline the high level of complexity in the measurement of sustainability (Heylighen (17)). We have concluded from this that the process of sustainability is itself made up of many elements which must be taken into consideration when measuring its efficiency.

The second process, of safety, concerns the natural effect of self degradation, particularly in the case of complex systems. Safety is the rate of change for any process which leads to the degradation of the system, as commented on by M. Leveson (18). The natural degradation of the environment and its systems is continuously measured worldwide and is the subject of the “World Disaster Report”. The measurement of system degradation is also complex, as is safety, but we are well-versed in the use of this well-known measure. As the two processes are evaluated with the same approach as the measurement of quality, we can consider that they hold a similar place in the conception of life. However, we can precise that the measurement of sustainability is a measure of the ability of the society, and thus the political system, to secure, and not compromise, at least the same quality of life for future generations. Conversely, the measurement of safety is the measure of the ability to facilitate the control of the steady-state of those systems which assure, at least, the minimum quality of life. Therefore, sustainability is linked to the ability to offer the best quality of life in the future, whereas safety is linked to the ability to measure change in the systems which assure the quality of life.

3.3. Multi-criteria examination of sustainability and safety

The measurement of sustainability and safety is a measurement of the quality of complex systems. The global political system is a complex one which contains the two principal processes of sustainability and safety. It is easy to understand that it is impossible to determine the quality of a political system from the daily detailed perceptions of the citizens. This is because, between the global complexity of the political system and the simple, perceptions of individual people, we have to measure the intermediate complexity of the processes of sustainability and safety. If we do not describe the evolution of the global system, using the Markov Model, we fail to measure the quality of these two intermediate processes. The principal mathematical criteria of the Markov Model is the use of a calculation of the evolution of these two processes, with the aggregation of the daily detailed perceptions and facts, and to be able to remain relatively stable during the time of evolution of the system, as opposed to detailed events which are not stable in the same period.

As the two processes are themselves complex, we have to find possible approaches for their measurement.

The evaluation of complex processes requires particular methodology which is always based on multi–criteria procedures. These are well-known as “The multi–criteria evaluation and assessment of complex systems”. An example of this can be found in economics (Hovanov, Fedotov, Kornokov (19)). Our purpose is not to design the relevant criteria for the measurement of sustainability and safety, ourselves. Our interest lies in the use of some of the criteria-elaboration methods which are available in the economic, organisational and systemic areas in order to include them in the Markov calculation. Therefore, we can now conclude that the final value of sustainability should be considered as the $\mu(t)$, repair ratio, and that the final value of safety should be considered as the $\lambda(t)$, degradation ratio, as described in our previous Markov calculation. It should be noted that the mathematical definition of safety is exactly the same as the direct one for the default ratio, that is zero default between 0 to T, or the approximated one, that is 1/ Mean Time To Degradation. Again, it should be noted that the same calculation can be applied to sustainability.

Also, sustainability offers some tools for its own measurement. Afgan and Carvalho (15) made a synthesis of sustainability with its four components, resource quality, environmental quality, technological quality and social quality. The first is measured with an integral thermodynamic approach (Prigogine,(20)), and internal parameters of change as “entropy production in the system” (Prigogine,(21)). The second can be measured with mutual interaction assessment between the complex system and its surrounding life system, and here there are many tools available. The third is measured with a very large array of tools for the measurement of quality performance in design and production systems. Finally, the fourth is measured with tools concerning social efforts towards improving quality in social systems. An example of this can be seen in Hacker and Roberts, (22).

We consider, now, that we have a method for the aggregation of elements, measured with the tools available, to make a measurement of sustainability, with significant reliability. This measurement can be made at any stage of the evolution of the complex system. If we obtain the results of sustainability measurement, over a given time, we can measure the change ratio

during this period and thus make a measurement of safety. Therefore, It is not necessary to have specific tools for the measurement of safety, because we can use the data obtained from the measurement of sustainability and apply it directly to the measurement of safety.

3.4. The use of the evaluation of a political system for its improvement

The global evaluation of a political system should not be made with a simple questionnaire on citizen satisfaction. As we learned from the multi–criteria evaluation, a political system is a second order complex system consisting of, at least, the two reverse processes of sustainability and safety. These, themselves, are first order complex systems, consisting of a multitude of micro–processes, which are themselves simple systems. It is only in these simple systems that we can find many direct, linear links between individual perception, emotions, attitudes and global satisfaction on the micro–process. In the first order and second order complex systems, it is necessary to make the calculation as follows:

- first, aggregate all the micro-measurements of the micro–processes, obtained with the multi–criteria approach, to calculate the value of sustainability and safety (the first complex level);

- secondly, calculate the global state of the evaluation of the political system using the Markov Model. This is a second complex level giving the percentage of position of the state between ideal state and disastrous state.

The theoretical definition of the ideal state is that one which gives 100% of the maximally-possible ideal life, the best quality of life for the immediate future that can be imagined, without any constraint. The disastrous state can be described from contemporary or historical examples. Therefore, if the actual state is evaluated at 61%, for example, it follows that the reality is at 61% of the imaginary state.

However, the Markov Model does not prescribe the use of that state 1 as 100%. A very simple use of the system is to take political promise as desirable future described by the politicians. It is not important to know what the percentage rating of this state is. We can use the same method to choose the state 2 from among the bad ones of which we know. In this case, the Markov Model is used to calculate the position of the real state, between a determined state 1, at X%, and a state 2, at Y%. A second measurement, made several months or years later, will be very reliable, for comparing the second real state with the first, under the condition that we keep the states, 1 and 2, at the same value, X% and Y%. It is only important to keep the same theoretical states 1 and 2, even if we do not know the exact values of X and Y. Therefore, we have a global measurement of the political system, giving reliable results of relative and comparative measurement in a given period of time, without being obliged to make real, absolute measurements of what would be the best imaginable level of quality of life or that which would be the most disastrous.

4. CONCLUSION

The direct measurement of global satisfaction of both customers and citizens, is impossible to carry out with a reliability greater than 62%, if it is based on direct questionnaires of people's snap perceptions. This accuracy rises to 97%, if the global quality, that is the global satisfaction, of a complex system like the political one (global customer satisfaction) is evaluated with a calculation of global satisfaction. This phenomenon was validated by the application of the Markov model, firstly in an energy power-plant system, which is not discussed here, and, secondly, to measure customer satisfaction at a Leisure Park, which was confirmed by further applications in Car Manufacturing and Banking, and which are also not discussed here. This calculation is made from people's detailed perceptions of the multiple-row processes of daily life activity, like those experienced by a citizen or a customer in contact with a Customer-Service Department. These perceptions are always composed of very simple elements of satisfaction or dissatisfaction, which can be measured easily, with a high level of reliability and feasibility, from the daily tasks, events and actions, which are carried out or observed by people. An important point of this research is the understanding that the global satisfaction of customers, and by the same token, the global evaluation of a political system, is not directly linked with the individual perceptions, and does not follow a simple, linear relationship between partial perceptions of the processes which make up the system, and the global perception of the total system.

The similarity, between global customer satisfaction with the service received and the perception of political systems, allows us to propose the use of the same Markov Model for the evaluation of the political system. Therefore, the description of the two principal processes, which comprises the system, has been made using sustainability and safety, followed by their definition and the elaboration of their measurement criteria.

However, one of the most important observations, arising from this research is that of a common mistake made by politicians. They confuse the desired outcome of the political system, which is an imagined state of the ideal,

'pleasant life', with the means of achieving it. These are two reverse processes: one, of propositions for sustainability and heavy control and the other, of safety actions of the people concerned. Politicians make the same confusion, in their analysis of results of soundings of Public Opinion, between the false evaluation of citizen's global satisfaction with their policies and the true measurement of satisfaction with their individual, detailed, daily life, which really affects the possibility of achieving a new-evaluated calculation of global satisfaction.

REFERENCES

[1] Cronin J.J., Taylor S.A., Servperf versus servqual : reconciling performance-based and perception-minus-expectations measurement of service quality, Journal of Marketing N° 58, 1994

[2] Aguinis H., (University of Colorado) "Crossing frontiers in quantitative and qualitative research methods", First international co-sponsored conference research methods division, Academy of Management, Lyon, France , March 2004

[3] Cohen J., Statistical power analysis for behavioral sciences, Hilsdale, NJ, Lawrence Erlbaum, 1988

[4] Eiglier P., Langeard E., Servuction, Marketing Services, Mc Graw Hill, 1987

[5] Parasuman A., Zeithaml V., Berry L., Communication and control process in the delivery of service quality, Journal of Marketing, April 1988

[6] Lepage A, « Qualisat », deposit of the method at INPI, France,1995

[7] Kano N., Nobuhiko S., Fumio T., Shinichi T, "Attractive quality and must be quality", Japan Society for Quality Control, Tokyo,1984

[8] Edvardson B., Gustafsson A., Enquist B., "Quality in new service development. Criterial success factors", QMOD, Italy, 2005

[9] Mauldin R. D.,Urbanski M., «Graph Directed Markov Systems Geometry and Dynamics of Limit Sets", Cambridge tracks in mathematics, Serie N° 148

[10] Gupta V., Murray R.M., Hassibi B., "On the control of jump linear Markov systems with Markov state estimation", American Control Conference, 2003

[11] Assises Nationales de le Recherche en Qualité, Palais des Congrès de Versailles, 12 /1997.

[12] Lepage A., « Le rôle de la compréhension des perceptions dans la qualité des projets de conception industrielle », Thèse de doctorat, Paris, 2000

[13] Report of United Nations Conference on Environment and Development, Rio de Janeiro, 1992

[14] Agenda 21, Chapter 35, Science for Sustainable Development , United Nations Conference on Environment and Development , 1992

[15] Afgan N.H., Carvalho M.G., Hovanov A.N., Energy System Assessment with Sustainability Indicators, Energy Policy 28, 2000

[16] Gianpiero M., Mayuari K., Postar G., Energy Analysis as a tool for sustainability: Lessons for complex system theory. Annals of the New York Academy of Science, 1999

[17] Heylighen F., The science of self – organization and adaptively , Free University of Brussels

[18] Leveson M., Demonstration of a safety analysis on a complex system, report of safeware, Engineering Comp., Seatle,1996

[19] Hovanov N. V., Fedotov Y. V., Kornikov V. V., General aggregation problem in economics, 4th international workshop In multiple criteria and game problems under uncertainty, Orehovo – Zuevo, 1996

[20] Prigogine I., Evaluation criteria, variational properties and fluctuations, non – equilibrium thermodynamics variational techniques and stabiblity, University of Chicago Press, 1996

[21] Prigogine I., Kondepudi D., Modern thermodynamics: from heat engine to dissipative processes, John Wiley, Chichester, 1998

[22] Hacker S., Roberts T., Transformational leadership: creating organizations of meaning, Quality Press, 2004