ORGANIZATIONAL CHANGE AS A STRATEGIC TOOL: THE CASE OF A PUBLIC ORGANIZATION IN BRAZIL

Marcelino José Jorge, Frederico A. de Carvalho, Daniela de Souza Ferreira, Cristina Monken Avellar and Andréa da Costa Souza

ABSTRACT

At the Instituto de Pesquisa Clínica Evandro Chagas, a public research institute, a purposeful organizational change restructured productive activities into the form of Integrated Action Programs (briefly, PAIs). Taking into account the complexity of the new format, this article defines and computes managerial indicators to temporally assess those programs. Several optimization models were specified, considering efficiency frontiers with either constant or variable returns to scale. Findings suggest that PAIs are consistent with a pro-efficiency strategic path between 2002 and 2006. To that extent both the choice of PAIs as an organizational format and the adopted strategy may be considered successful.

Keywords *- Data Envelopment Analysis, Managerial indicators, Organizational innovation, Pro-efficiency strategy, Public research institute, Returns to scale*

INTRODUCTION

FIOCRUZ (Fundação Oswaldo Cruz), a technological and scientific centennial Brazilian organization - develops research, offers teaching and education programs, produces vaccines, drugs and medicines, provides scientific reference services and disseminates health information. Among the divisions composing Fundação Oswaldo Cruz, IPEC (Instituto de Pesquisa Clínica Evandro Chagas) is the unit dedicated to laboratory diagnosis, clinical service, teaching and education, as well as to research on several infectious diseases deemed relevant in terms of public health policy.

Since 1999 IPEC (Instituto de Pesquisa Clínica Evandro Chagas) adopted an organizational structure comprising several programs of integrated action (Programas de Ação Integrada, briefly PAIs) with a view toward enhancing the interaction among those activities, accumulating reputation and mobilizing resources for the development of clinical research on infectious diseases. In consequence of restructuring, during 2002 – 2006, IPEC (Instituto de Pesquisa Clínica Evandro Chagas) experienced a significant

Corresponding Author: marcelino.jorge@ipec.fiocruz.br

budget increase, diversified and expanded its activities.

With such an evolution in mind, the present article intends to accomplish three objectives, namely: (a) to measure the performance of the programs of integrated action (Programas de Ação Integrada, PAIs), (b) to evaluate the efficacy of the new organizational structure and (c) to investigate scale inefficiencies eventually existing in the programs. The text is organized in four sections that follow this introduction. The second section summarizes the prominent facts about the growth and the restructuration of IPEC (Instituto de Pesquisa Clínica Evandro Chagas) during 2002 - 2006, in addition to presenting the research problem of evaluating the organizational efficacy of the programs of integrated action (Programas de Ação Integrada, PAIs). The next section discusses the choice of Data Envelopment Analysis (DEA) as the main tool for computing managerial indicators that will be used to perform the efficiency analysis as well as to evaluate the efficacy of the organizational structure along the period 2002-2006. The fourth section presents the main findings, relating especially to scale inefficiencies and returns to scale. Finally, the concluding section takes up some pro-efficiency prescriptions in terms of operating plans for the programs of integrated action (PAIs).

BACKGROUND

In Brazilian S & T institutions, since the years 90 a wider managerial autonomy coexisted with greater resource restrictions and with larger expenses by those organizations in managerial tools directed to internal definition of priorities, to accountability and to the search for efficiency and efficacy. Accordingly, the change in the management model at FIOCRUZ (Fundação Oswaldo Cruz), since 1994, resulted in both managerial decentralization and restructuration at IPEC (Instituto de Pesquisa Clínica Evandro Chagas).

At the same time, since the uncertainty concerning infectious diseases was aggravating, responsiveness by the Public Sector became more demanding. Public health responsiveness depends on the existence of flexible organizations – such as IPEC (Instituto de Pesquisa Clínica Evandro Chagas) – carefully conceived with multipurpose scope and anticipating abilities that will be employed in future production and diffusion of knowledge, in diagnosis and in health care relating to a spectrum of target priority areas pertaining to health policy.

From 1985 on IPEC (Instituto de Pesquisa Clínica Evandro Chagas) revitalized several laboratories (namely pathological anatomy, bacteriology, hemotherapy, immunology, mycology, parasitology and clinical pathology), the outpatient clinic, the day-hospital service, the admission service (30 beds) and the constitution of clinical research cohorts. In 2006 output yielded 243,730 exams, 13381 consultations by infectologists, 2870 day-hospital assistances, 4374 admissions-day, 64 papers in indexed periodicals, 19 M.Sc. dissertations and 745 inclusions of patients into clinical research databases. In particular, regarding the activities of outpatient clinical service – namely, diagnosis and care – there was an increase in the quantity of service provided amounting to some 20% during 2005-2006.

In that same period IPEC (Instituto de Pesquisa Clínica Evandro Chagas) implemented diversified integrated action programs (PAIs) with a view to gaining reputation as an S & T institution and to building the image required for having access to increased resources for clinical research on infectious diseases. There were fourteen integrated action programs (PAIs) in 2006, whose majority has been nationally recognized as Reference Centers on Infectious Diseases in diverse layers of SUS, the national public health system.

The present article intends to evaluate whether the organizational restructuration of IPEC (Instituto de Pesquisa Clínica Evandro Chagas), starting in 1999, has been possible not only by simply increasing the budget, but also due to an efficient internal (re)distribution of budgetary resources among the programs. Therefore, in order to assess the efficacy of the management model, the article will (a) build up and interpret Managerial Indicators (IGs) computed from a DEA model of efficiency analysis that covers a subset of selected integrated action programs (PAIs); and (b) apply those IGs for investigating the presence and the nature of scale inefficiencies in that subset of programs. Findings from both items are expected to allow for pro-efficiency prescriptions for IPEC (Instituto de Pesquisa Clínica Evandro Chagas).

METHOD

When studying any production process in a given organization, if a production unit uses the same resources but yields greater quantities of output than another unit, it will be considered "relatively more efficient", no matter how formally the productivity problem is analyzed. Analogously if the production unit uses less resources and yields the same output.

Due to several problems arising in regard to the interpretation of the IGs, in the literature about organizational evaluation the comparison between organizational units is performed via the identification of the efficiency frontier, that is, the locus of all "equally best productive combinations of inputs and outputs". Once identified the frontier, the performance of a specific organization may be evaluated by assessing the relative position of the component units relatively to each other and to the frontier.

Data Envelopment Analysis (DEA), a name for a class of mathematical programming models, has long been applied to a broad range of situations involving the economics of management (e. g., Coelli, Rao and Battese, 1998; Jogging, Much and Tone, 1999), either in the public sector (e. g., Fox, 2001; Smith and Street, 2005; Afonso, 2006) or in private business, including nonprofit organizations (e. g., Nunamaker, 1985; Vakkuri, 2003; Fare, 2006).

The so called nonparametric models of frontier adjustment, such as DEA, represent the efficiency frontier as the best observed practices, that is, as the maximum output obtained from an input bundle when considering all the empirically observed organizational units in the population studied. Hence, those models assume that there may occur non-allocative inefficiencies in the production process. Those inefficiencies may result from reasons outside managerial control so that they do not constitute

"technical problems" in the sense of either production technology or production management.

Following the selection of appropriate performance indicators and the application of DEA method, the article evaluates to what extent the new organizational format has been adequate, during the period of study, as a basis for allocative decisions in a "complex" organization such as the Instituto de Pesquisa Clínica Evandro Chagas – that is, a multipurpose organization using specialized resources and subject to various conflicts of interest (Rozek, 1988).

Regarding the specific objectives of production management, namely the assessment of whether the operating plans currently directed to expansion should be adjusted, the article analyses whether the increase in scale resulted in efficiency losses for the integrated action programs (PAIs). For that purpose data were collected on inputs and outputs associated to eight programs for the period 2002 – 2006: Chagas Disease; DFA / Dengue; HIV; HTLV; LTA; Mycosis; Toxoplasmosis; and Tuberculosis. In terms of the application of DEA, each program has been considered a decision-making unit (DMU).

The following variables were considered as Inputs:

Hour – doctor: meaning the time dedicated by medical professionals to each program;

Medicament – year: representing the expenses with medicines in each program;

Reagent – year: meaning the annual expenses with kits and reagents for several exams as distributed per program; and

Hospital Materials – referring to annual expenses with hospital materials by program.

The following variables have been considered as the outputs of the eight programs:

Exams – meaning the quantity of exams carried out by program;

Consultations – the quantity of consultations provided in each program;

Admissions – number of annual admissions;

PAI – a dummy variable to indicate the annual evolution of program reputation;

Scientific Output – describes the quantity of scientific papers published by program;

Cohort – the quantity of patients included in each program for research purposes;

Education – the quantity of dissertations and theses completed / defended in each program; and

Reference – indicates the quantity of searches in medical files by students under the supervision of any researchers in each program.

Today it may be said that DEA is an approach encompassing a collection of models (Cooper, Seiford and Tone, 1999). Among many options of models to be experimented with and/or computed, the efficiency analysis developed in this article employs a nine-variables version called *output-oriented with variable returns on scale* (briefly, DEA-BCC-O).

There are at least two reasons for that choice. First, the Institute's annual budget is pre-established so that any efficiency search must envisage aggregate input use as fixed whereas looking for output maximization; hence the output-oriented approach seems to be preferable to an input-oriented version. Second, since learning effects stemming from service experience acquired from patient care result in scale economies in (service) production, the short time period covered in the present analysis leads to discarding the assumption of constant returns, a typically long term hypothesis.

For mathematical convenience, the reputation dummy was excluded and three input variables have been aggregated into "current expenses except personnel": medicaments, reagents and hospital materials.

FINDINGS

In agreement to a comprehensive growth trend in overall organizational activities during 2002-2006, Table 1 indicates that the eight selected programs altogether have shown a sustained increase in physical output. From the input expenditure viewpoint, Table 2 indicates a significant increase in the quantity of resources mobilized for the selected integrated action programs during the period.

Having solved the optimization problem defined by the model DEA-BCC-O by means of the package *Frontier Analyst*®, the relative technical efficiency scores are obtained for each program-year, as presented in Table 3. Figures show that program efficiency varied throughout period of analysis.

In fact, since the yearly average score represents relative technical efficiency for the whole set of integrated action programs (PAIs) at the corresponding year, the computed scores for 2002-2004 indeed confirm the conclusion that no efficiency losses occurred along that period (Buzanovsky, 2006), whereas the decrease for the next biennium indicates that although the production volume has increased, previous efficiency gains disappeared and have even turned down.

Given the complexity of the integrated action programs (PAIs) as organizational structures, a question immediately stirred up by that interruption in efficiency growth relates to verifying the extent to which there were any management barriers binding the efficiency path suggested in the beginning of the period and, for that matter, implying the presence of scale diseconomies (Arrow, 1964).

Table 1. Evolution of Physical Output of PAI Programs: 2002 – 2006

OUTPUT VARIABLES	2002	2003	2004	2005	2006
Exams (number)	197'055	242'655	252'466	228'652	243'730
Consultations (number)	10'270	11'253	12'294	19'024	13'381
Admissions (number)	5'892	6'586	3'955	7'399	4'374
Scientific Output (in articles)	83	72	78	98	83
Cohort Inclusions (number)	563	641	690	745	745
Oriented Search (number)	14	7	5	5	8
Education (in UPPs)	24	96	112	24	68

Table 2. Input Utilization: 2002-2006

INPUTS	2002	2003	2004	2005	2006
Hours-Doctors (number.)	42.051	42.008	85.657	103.558	115.438
Current Expenses (in R$) (excludes Personnel)	591.610,63	1.105.818,53	1.248.530,38	1.611.745,79	2.030.150,03

There are two aspects to be explored. First, do the productive activities of integrated action programs (PAIs) present variable returns to scale? If yes, are there increasing or decreasing returns? The answer to these questions is important to the extent that decreasing returns would just mean that growth initiatives might be harmful along the period.

To answer those questions a model DEA-BCC-I was computed with the Frontier Analyst® and new efficiency scores obtained as presented in Table 4. In comparison to the figures in Table 3, corresponding to DEA-BCC-O, note that the new benchmark frontier - and different efficiency scores - indicates the presence of variable returns to scale (Coelli, Rao and Battese, 1998).

Of which kind might those variable returns be? Two additional optimization problems have been computed, using the Excel Solver, to answer this question. According to Table 5, there is evidence of increasing returns to scale for program activities during the period - the efficiency scores calculated with the input-oriented DEA model with constant returns on scale equal those obtained with the input-oriented DEA model with non-increasing returns to scale (Coelli, Rao and Battese, 1998).

Table 3. Average Efficiency Scores (in %): Model DEA-BCC-O

PAI	2002	2003	2004	2005	2006
Chagas	84,93	85,70	86,26	98,63	81,65
DFA/Dengue	87,98	100,00	98,29	100,00	100,00
HTLV	100,00	84,84	100,00	82,53	82,20
Leishmaniosis	100,00	100,00	100,00	97,25	100,00
Mycosys	100,00	100,00	100,00	100,00	100,00
Toxoplasmosis	100,00	100,00	100,00	100,00	90,92
Tuberculosis	100,00	100,00	100,00	100,00	95,67
HIV	100,00	100,00	100,00	100,00	100,00

Table 4. Efficiency Scores (in %): BCC-I model

PAI	2002	2003	2004	2005	2006
Chagas	68,05	66,14	42,78	95,16	49,97
DFA/Dengue	59,82	100,00	94,33	100,00	100,00
HTLV	100,00	71,40	100,00	40,09	46,55
Leishmaniosis	100,00	100,00	100,00	81,70	100,00
Mycosys	100,00	100,00	100,00	100,00	100,00
Toxoplasmosis	100,00	100,00	100,00	100,00	60,67
Tuberculosis	100,00	100,00	100,00	100,00	66,89
HIV	100,00	100,00	100,00	100,00	100,00
Average	90,98	92,19	92,14	89,62	78,01

Table 5. Efficiency Scores (in %): NIRS-I and CCR-I models

PAI	2002	2003	2004	2005	2006
Chagas	68.07	64.38	37.38	69.54	55.63
DFA/Dengue	55.17	58.79	42.55	52.26	45.00
HTLV	100.00	70.62	52.67	35.56	38.28
Leishmaniosis	100.00	100.00	100.00	56.23	79.68
Mycosys	100.00	100.00	95.77	62.71	58.61
Toxoplasmosis	100.00	100.00	100.00	100.00	100.00
Tuberculosis	100.00	100.00	58.25	59.34	42.05
HIV	100.00	100.00	28.12	62.62	64.43
Average	90.41	86.72	64.34	62.28	60.46

CONCLUSIONS

The application of efficiency analysis to understand the organizational restructuration experienced by IPEC (Instituto de Pesquisa Clínica Evandro Chagas) brought about a comprehensive result of interest: due to incomplete information on the part of managers concerning the productive activities of the complex organization where they belong and to the pre-established nature of their budgetary resources, the implicit hypothesis under which the integrated action programs (PAIs) operate yearly (i. e., "look at your peers and maximize ouput") is consistent with DEA-BCC-O model so that its application is useful to explain how short-term operational plans have been chosen and managed

Marcelino José Jorge, DSc., Head, Cost Monitoring Section, Evandro Chagas Institute for Clinical Research, Oswaldo Cruz Foundation, Brazil. E-mail: marcelino.jorge@ipec.fiocruz.br

Frederico A. de Carvalho, DSc., Associate Professor, College of Business and Accounting, Federal University at Rio de Janeiro, Brazil. E-mail: fdecarv@gmail.com

Daniela de Souza Ferreira, MBA, Administrative Analyst, Cost Monitoring Section, Evandro Chagas Institute for Clinical Research, Oswaldo Cruz Foundation, Brazil. E-mail: daniela.ferreira@ipec.fiocruz.br

Cristina Monken Avellar, Economist, Administrative Analyst, Cost Monitoring Section, Evandro Chagas Institute for Clinical Research, Oswaldo Cruz Foundation, Brazil. E-mail: cristina.avellar@ipec.fiocruz.br

Andréa da Costa Souza, MBA, Administrative Analyst, Cost Monitoring Section, Evandro Chagas Institute for Clinical Research, Oswaldo Cruz Foundation, Brazil. E-mail: teka.dea@hotmail.com

during 2002-2004 (Jorge, 2006a).

In addition, due to cross learning among programs, it may be said that the improvement occurring in that period did not depend on any substantial increase in the resources available to the DMUs and that such improvement resulted by simply allowing the managers to adopt pro-efficiency strategies when choosing their short run operational plans.

The short period of time covered by the present analysis does not contemplate situations of long term equilibrium such as those implicit in the hypothesis of constant returns to scale. That's why the decrease in the annual average score for the subsequent biennium may be interpreted as indicating that, despite the initial trend of growing gains, the increase in productive activity in fact took place in a context of inverted efficiency trend.

Summing up, the article analyzed two main questions. First, it investigated whether managerial constraints occurring in a "growth-cum-diversification" setting may bring about scale inefficiencies that, in addition to depicting the output growth path, would be compatible with a pro-efficiency strategy manifested in the simultaneous production of reference services, scientific knowledge and human resources for clinical research on infectious diseases. Second, the article examined which implications might result from scale inefficiencies in terms of impacting upon the short run operational choices opened up for both program and institutional managers at IPEC (Instituto de Pesquisa Clínica Evandro Chagas).

Regarding the first question, it was shown that DEA models CCR, BCC and NIRS may empirically explain the existence of distinct productive processes where maximum productivity varies in function of output scale. Those models allowed to contemplate, at one same time, DMUs with differing sizes as well as to establish the nature of corresponding scale inefficiencies, whenever present. In what the second question is concerned, the models computed here identified the presence of increasing returns to scale for the period 2005-2006, so that it may be concluded that if activity levels are increased, then efficiency gains will result in the future. At the same time, the choice of integrated action programs (PAIs) as an organizational format, as well as the ongoing growth strategy are corroborated.

The managerial indicators (IGs) proposed and computed here may therefore serve for routine follow-up of program performance by technical staff. In that sense the article has pointed out ways toward human resources qualification by means of new managerial tools. The numerical nature of this tool allows for simulation and experimentation that may help developing new insights on organizational positioning and improvement. In other words, the analysis presented here is closely related to the production and use of organizational data that may help understand the multiple aspects of goal setting, policy implementation and feasibility constraints occurring in public organizations devoted to S & T activity (Jorge, 2006b).

Finally caution should be raised concerning robustness of findings. In fact, since the indicators (IGs) have been computed with the help of (non parametric but) deterministic models, their estimation is fully dependent on data quality. Therefore, permanent care

must be exercised to make sure that the relevant variables are identified and that their measurement is as accurate as possible. To help cope with the structure and behavior of errors along the modeling process, future research should then include some robust version of frontier estimation (Daraio and Simar, 2007), as well as the application of simulation techniques, e.g. bootstrapping (Buzanovsky, 2006) or jackstrapping (Stosik and Sousa, 2003; Sousa and Stosik, 2005). In any case, it is worth mentioning that, due to institutional features, data collection is made under a one year delay, a binding condition that will very likely persist for some time yet. Of course, many improvements will result from updating and extending the existing database, and hence increasing the length of all series now available. This endeavor is a permanent objective of the research group.

REFERENCES

Afonso, A., L. Schuknecht and V. Tanzi. 2006. Public Sector Efficiency: Evidence for New EU Member States and Emerging Markets. Frankfurt: European Central Bank, Working Paper Series Nº 581.

Arrow, K. 1964. "Control in Large Organizations". Management Science, 10/3: 397–408.

Buzanovsky, N. 2006. Mensuração de Performance pelo Método DEA: Um Estudo de Caso no IPEC/FIOCRUZ. MSc. Dissertation, Universidade Cândido Mendes.

Charnes, A., W. W. Cooper and E. Rhodes. 1978. "Measuring the Efficiency of Decision-Making Units". European Journal of Operational Research, 2/6: 429-444.

Coelli, T., D. S. P. Rao and G. E. Battese. 1998. An Introduction to Efficiency and Productivity Analysis. Boston: Kluwer Academic Publishers.

Cooper, W. W., L. M. Seiford and K. Tone. 1999. Data Envelopment Analysis: a Comprehensive Text with Models, Applications, References and DEA–Solver Software. Boston: Kluwer Academic Publishers.

Daraio, C. and L. Simar. 2007. Advanced Robust and Nonparametric Methods in Efficiency Analysis: Methodology and Applications. New York: Springer.

Fox, K. J. 2002. Efficiency in the Public Sector. Boston: Kluwer Academic Publishers.

Jorge, M. J. 2006a. IPEC – Custo Unitário Efetivo e Valor de Pagamento pelo Custo do Exame: 2006. Rio de Janeiro: IPEC/FIOCRUZ, Estudo de Avaliação Descritiva nº 6.

Jorge, M. J. 2006b. Efetividade em Custo e Análise de Eficiência de Programas em Organizações Complexas: a Experiência do IPEC/FIOCRUZ. Rio de Janeiro: IPEC/FIOCRUZ, Estudo de Avaliação Analítica Nº 4.

Nunamaker, T. R. 1985. "Using DEA to Measure the Efficiency of Non-profit organizations: a critical evaluation". Managerial and Decision Economics, 6/1: 50-58.

Rozek, R. P. 1988. “A Nonparametric Test for Economies of Scope”. Applied Economics, 20/5: 653-663.

Sousa, M. C. S. and B. Stosik. 2005. “Technical Efficiency of Brazilian Municipalities: correcting nonparametric frontier measurements for outliers”. Journal of Productivity Analysis, 24/2: 157-181.

Stosik, B. and M. C. S. Sousa. 2003. Jackstrapping DEA Scores for Robust Efficiency Measurement. Rio de Janeiro: Departament of Economics, Universidade de Brasília, Discussion Paper Nº 291.

Smith, P. C. and A. Street. 2005. “Measuring the Efficiency of Public Services: the limits of analysis”. Journal of the Royal Statistical Society – Series A, 168/2: 401-417.

Vakkuri, J. 2003. “Research Techniques and Their Use in Managing Non-profit Organizations: an illustration of DEA analysis in NPO environments”. Financial Accountability and Management, 19/3: 243-263.

About IPMR

IPMR The International Public Management Review (IPMR) is the electronic journal of the International Public Management Network (IPMN). All work published in IPMR is double blind reviewed according to standard academic journal procedures.

The purpose of the International Public Management Review is to publish manuscripts reporting original, creative research in the field of public management. Theoretical, empirical and applied work including case studies of individual nations and governments, and comparative studies are given equal weight for publication consideration.

IPMN The mission of the International Public Management Network is to provide a forum for sharing ideas, concepts and results of research and practice in the field of public management, and to stimulate critical thinking about alternative approaches to problem solving and decision making in the public sector.

IPMN includes over 1300 members representing about one hundred different countries, both practitioners and scholars, working in all aspects of public management. IPMN is a voluntary non-profit network and membership is free.

ISSN 1662-1387