MEASUREMENTS OF QUALITY AND SYSTEMIC PRODUCTIVITY IN THE BRAZILIAN SOFTWARE INDUSTRY

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Trabalho apresentado durante o IX IPS – International Productivity Symposium, Curitiba/PR, maio de 2000.

ABSTRACT

From 1993 on Brazil is looking for the achievement of international standards on quality and productivity in the software sector. Based on surveys applied every two years, there are currently available national databases of software quality information. This paper presents the main findings of the 1999 Software Quality Survey compared with the previous ones from 1995 and 1997. This paper also presents an innovation – there were collected data in the 1999 Survey to assess the Systemic Productivity (SP) of the Brazilian software industry and its main results are available on it.

1. INTRODUCTION

Brazil is a huge country: the Brazilian population (160 million inhabitants) is 40% of the Latin American people and the Brazilian GDP in 1998 (US$ 860 billion) was 60% of the Latin American gross product. Despite global economic turmoil in the beginning of 1999, Brazil has shown sign of an impressive recovery. Early in the 21st Century, the big challenge is the insertion of Brazil in the new Digital Economy and in the emerging Knowledge Society.

According to Weber et a.(1999), Brazilian software is a critical leverage tool for Brazil's drive to compete in the global marketplace, from the agribusiness to the aerospace industry, and to improve education and health care for solving acute social problems. The software industry is becoming an important player to the Brazilian economy. It is made up of developers of packaged and custom software, companies which embed software in their products, and companies which develop Internet-related software. As shown in Table I, the growth rate in software revenues has had the best performance in the domestic market from 1991 to 1999, when compared to hardware and related services.

INFORMATION TECHNOLOGY	Revenues (US$ billion)		Growth Rate 1991 / 1999	
	1991	1999	Total	Annual
Software (1)	**1.1**	**4.3**	**291%**	**19%**
Related Services (2)	1.9	5.2	174%	13%
Hardware (3)	4.1	9.3	127%	11%
Total	7.1	18.8	165%	13%

Source: MCT/SEPIN (http://www.mct.gov.br)

(1) Only packaged and custom software, 60% of them developed in Brazil;
(2) It includes software-related services;
(3) It includes embedded software

Table I – IT Revenues in Brazil

In the export front, the work of the Brazilian Society for Promoting Software Export – SOFTEX is beginning to show positive results. Brazilian software's revenues from export were close to US$ 40 million in 1998, an evolution compared to less than US$ 1 million

exported in 1991. The main goal is to export US$ 250 million in 2002 or, in other words, to shift Brazilian software exports from tens to hundreds of millions each year.

The Brazilian government created the PBQP (Brazilian Quality and Productivity Program) in 1990 and installed the PBQP/SSQP-SW (PBQP Software Subcommittee) in 1993, looking for "the achievement of international standards on quality and productivity in the software sector" (Weber and Pinheiro, 1995).

In this sense, the objectives of this paper are to present the findings of the Brazilian Software Quality surveys in 1995, 1997 and 1999, and the main results of the 1999 Systemic Productivity survey in the Brazilian Software Industry.

2. SOFTWARE QUALITY AND PRODUCTIVITY MEASUREMENTS IN BRAZIL

Since 1993 the evolution of quality in the Brazilian software companies have been followed up through direct surveys carried out every two years by MCT/SEPIN (the Technology Information Policy Department from the Brazilian Ministry of Science and Technology), in cooperation with the PBQP Software Subcommittee.

According to MCT/SEPIN, the number of Brazilian software companies in the domestic market is estimated on 2500 and the number of software companies in these surveys were: 282 in 1993; 445 in 1995; 589 in 1997; and again 445 in 1999.

Results from these surveys are available in national databases of software quality information at MCT/SEPIN (http://www.mct.gov.br). Some selected indicators and the correspondent figures show a continuous improvement in the Brazilian software quality (see Table II).

Software Quality Selected Indicators	1995	1997	1999
Percentage of software companies with ISO 9000 certification	2%	8%	17%
Percentage of software companies using CMM	3%	5%	10%
Percentage of software companies using ISO/IEC 9126 for product evaluation	-	7%	10%
Percentage of the annual revenue invested in training for software quality improvement	-	2.5%	2.3%
Percentage of software companies applying systematically customer satisfaction surveys	19%	25%	29%

Table II – Software Quality Improvements in Brazil

Besides the software quality information, MCT/SEPIN's surveys in 1995, 1997 and 1999 also include some software project productivity information, based on the use of the following metrics:

- the lines of code (LOC) metric, which was more effective in the past when the code was the dominant cost driver; and
- the function point (FP) metric, which has grown its use worldwide in the 1990s.

MCT/SEPIN's surveys in 1993, 1995, 1997 and 1999 have aimed at assessing the evolution of the Brazilian software quality using six key indicators, namely: *(i)* quality systems; *(ii)* software process quality; *(iii)* software product quality; *(iv)* workforce

management quality, *(v)* customer relationship quality; and *(vi)* software quality procedures.

2.1. Quality Systems

The main issues explored on quality systems refer to strategic and business planning, goals and guidelines for quality, quality indicators, quality costs and Total Quality Management.

The percentage of software companies that developed strategic plans, business plans or goal plans, after remaining stabilized around 57% in 1995 and 1997, raised to 68% in 1999; and 69% of those companies include goals and guidelines for quality in their plans.

While 10% of the software companies in 1995 accounted the quality costs in a systematic way or in specific projects, 27% accomplished such accounting in 1999, including prevention and correction costs.

The number of software companies with Total Quality Management or similar systems in Brazil grew from 11% to 26% in the period 1995-1999.

2.2. Software Process Quality

The software process quality in the Brazilian software companies is assessed through issues such as ISO 9000 certification and the use of CMM - Capability Maturity Model, SPICE - Software Process Improvement and Capability dEtermination (Technical Report ISO/IEC TR 15504), and the International Standard ISO/IEC 12207 - Information Technology: Software Life Cycle Processes.

In 1993, there were only 3 software companies ISO 9001 or ISO 9002 certified. This number rose from 8 in 1995 to 45 companies in 1997, achieving 72 companies in 1999. The evolution of the percentage of Brazilian software companies with ISO 9001 or ISO 9002 certification is as follows: 2% in 1995, 8% in 1997, and 17% in 1999.

The percentage of Brazilian software companies using the CMM – Capability Maturity Model, from CMU/SEI, is also growing: 3% in 1995, 5% in 1997, and 10% in 1999.

The knowledge of SPICE presented significant historical increases: 18% in 1997 and 30% in 1999.

The main metrics used in Brazil for software process quality analysis are: *(i)* lines of code (LOC), used by 13% of the companies; and *(ii)* function point (FP), used by 19% of the companies.

2.3. Software Product Quality

The software product quality in the Brazilian companies is evaluated according to the International Standard ISO/IEC 9126 - Information Technology: Software Product Evaluation - Quality characteristics and guidelines for their use, and ISO/IEC 12119 - Information Technology: Software Packages - Quality requirements and testing.

In 1997, 26% of the companies knew ISO/IEC 9126 or ISO/IEC 12119 and 7% used them systematically or were beginning to use. In 1999, the knowledge of ISO/IEC 9126 reached 36% of the companies, with 10% using it, while 31% knew the ISO/IEC 12119, with 6% using it.

2.4. Workforce Management Quality

In 1999, informal procedures to promote employees participation in the solution of problems were used in almost 40% of the companies and work meetings were promoted in almost 80% of the companies, representing substantial gain on the percentage of 44% in 1993. Teams or quality control circles has represented close to 20% since 1997.

The percentage of the annual revenue invested in training people for software quality improvements were 2.5% in 1997 and 2.3% in 1999.

2.5. Customer Relationship Quality

For client support and resolution of complaints, in 1993 more than 70% of the companies and 64% in 1999 maintained formal customer support structures.

New structures are appearing: hot line services and help desk in 66% of the software companies in 1999 against just 11% in 1993; and remote support through Internet with almost half of the companies in 1999.

Customer satisfaction surveys are being applied systematically in a increasing number of Brazilian software companies: 19% in 1995, 25% in 1997, and 29% in 1999. These surveys and the follow-up of the customers complaints are used by 78% of the companies in the revision of their projects or in the specification of new products or services.

2.6. Software Quality Procedures

There are also information on the main software engineering methods, organized in different subsets of techniques for software quality improvement, in agreement with Capers Jones (1995 and 1997) classification: prevention defect methods and detection defect methods.

The main software prevention defect methods used in Brazil are: quality procedures and work instructions; prototyping; critical analysis; and project management.

The main detection defect methods used in Brazil are: functional tests; field tests; validation and integration tests; tests of the integrated system; and acceptance tests.

3. FIRST SYSTEMIC PRODUCTIVITY MEASUREMENTS IN THE BRAZILIAN SOFTWARE INDUSTRY

Weber and Amaral (1999) reported that the Brazilian software industry was chosen by IBQP-PR (the Brazilian Institute for Quality and Productivity in Parana) to be a pilot test in 1999 of its new model called Systemic Productivity (SP), developed with the technical support of JPD-SED (Japan Productivity Center for Socioeconomic Development).

In this model, there are five productivity factors (inputs): people, natural resources, inventory, facilities, and management; and there are two references: comparison of results (benchmarking) and distribution of value added. In the first survey applied to the Brazilian software industry in 1999, there were used only two factors (people and management) and one reference (distribution of value added). The next survey in 2001 will include more productivity factors and comparison of results.

In this first Systemic Productivity (SP) survey, data were collected from 193 Brazilian software companies, jointly with the 1999 MCT/SEPIN's survey, and the answers from 177 companies were able to be processed by IBQP-PR.

These Brazilian software companies were ranked by their workforce size: micro (μ) – 1 to 10 employees; small (s) – 11 to 50 employees; medium (m) – 51 to 100 employees; and big (b) – more than 100 employees.

3.1. Productivity Indicators

The micro- and small-size Brazilian software companies show the best results (see Table III) in productivity indicators related to the Management factor (Total Capital Productivity and Net Profit Margin) and to the People factor (Sales per Employee and Labor Productivity, both in the upper limit).

BEST RESULTS			
Productivity Indicators	**Upper Limit**	**Average**	**Lower Limit**
1) Value Added Ratio	b	μ	m
2) Total Capital Productivity	s	s	s
3) Profitability	s	μ	m
4) Net Profit Margin	μ	μ	μ
5) Sales per Employee	μ	b	b
6) Labor Productivity	μ	b	b
7) Personnel Expenses Contribution	μ	μ	μ
8) Labor Share Ratio	m	m	m
9) Owned Capital Share	μ	μ	μ

Software companies workforce size: μ (micro), s (small), m (medium), and b (big)

Table III – Productivity Indicators in the Brazilian Software Industry (best results)

The medium- and big-size Brazilian software companies show the worst results (see Table IV) in productivity indicators related to the Management factor (Value Added Ratio and Total Capital Productivity) and to the People factor (Labor Productivity and Personnel Expenses Contribution).

WORST RESULTS			
Productivity Indicators	**Upper Limit**	**Average**	**Lower Limit**
1) Value Added Ratio	m	m	m
2) Total Capital Productivity	m	m	b
3) Profitability	b	b	b
4) Net Profit Margin	b	b	b
5) Sales per Employee	m	μ	s
6) Labor Productivity	m	m	m
7) Personnel Expenses Contribution	m	m	m
8) Labor Share Ratio	μ	μ	μ
9) Owned Capital Share	b	b	b

Software companies workforce size: μ (micro), s (small), m (medium), and b (big)

Table IV – Productivity Indicators in the Brazilian Software Industry (worst results)

3.2. Value Added Distribution

Figures 1 to 4 show the Value Added (VA) distribution in the Brazilian software companies.

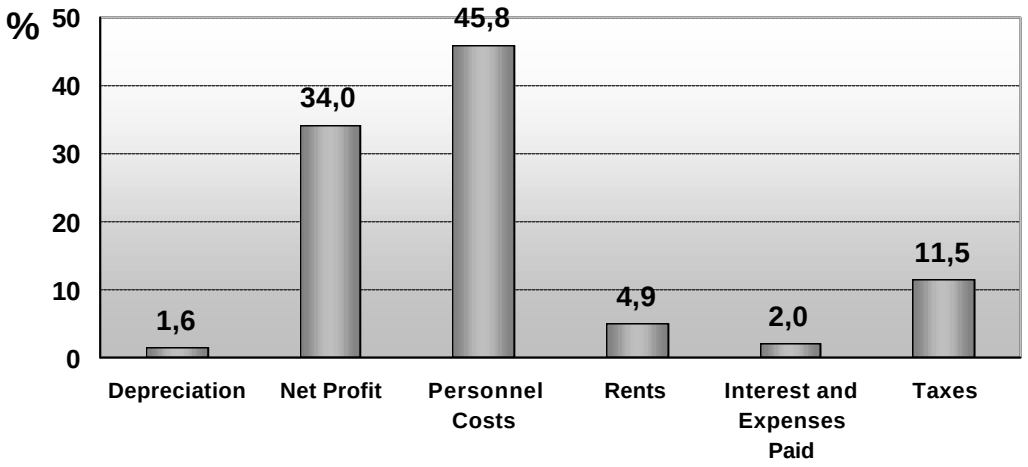

Figure 1 - Value Added distribution in micro Brazilian software companies (1-10 employees)

The most significant VA component for all Brazilian software companies, Personnel Costs range from 45.78% (micro-size companies) to 71.90% (medium-size companies).

Net Profit is the second most significant VA component for the micro- (34.03%), small- (27.02%), and medium-size (16.13%) Brazilian software companies.

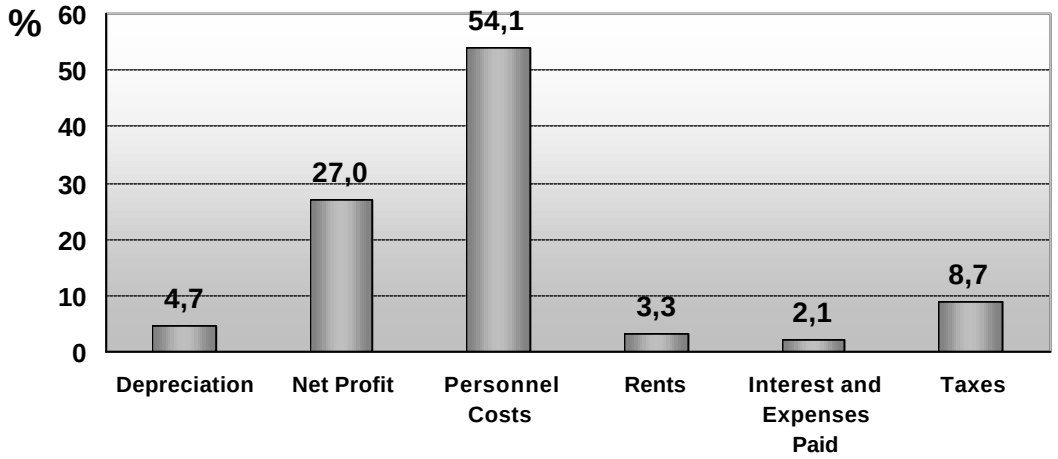

Figure 2 - Value Added distribution in small Brazilian software companies (11-50 employees)

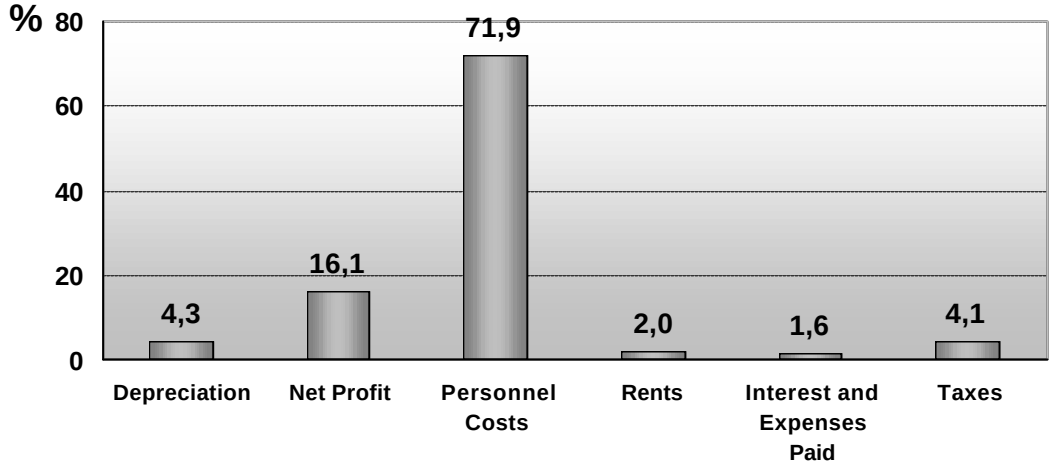

Figure 3 - Value Added distribution in medium Brazilian software companies (51-100 employees)

Depreciation is more significant to the big- (11.75%) than to the medium- (4.33%) and small- (4.73%) size companies, but it is the less significant VA component to the micro-size (1.65%) Brazilian software companies.

Taxes impact more on the micro- (11.55%) than on the small- (8.72%), medium- (4.06%) and big-size (5%) Brazilian software companies.

Rents is one of the less significant VA components for the medium- (1.96%) and big-size (1.71%) Brazilian software companies, but it amounts 3.31% in the small- and 4.99% in the micro-size companies.

Interest and Expenses Paid is another of the less significant VA components for micro- (2.04%), small- (2.11%) and medium-size (1.61%) Brazilian software companies, but it amounts 4.36% in the big companies.

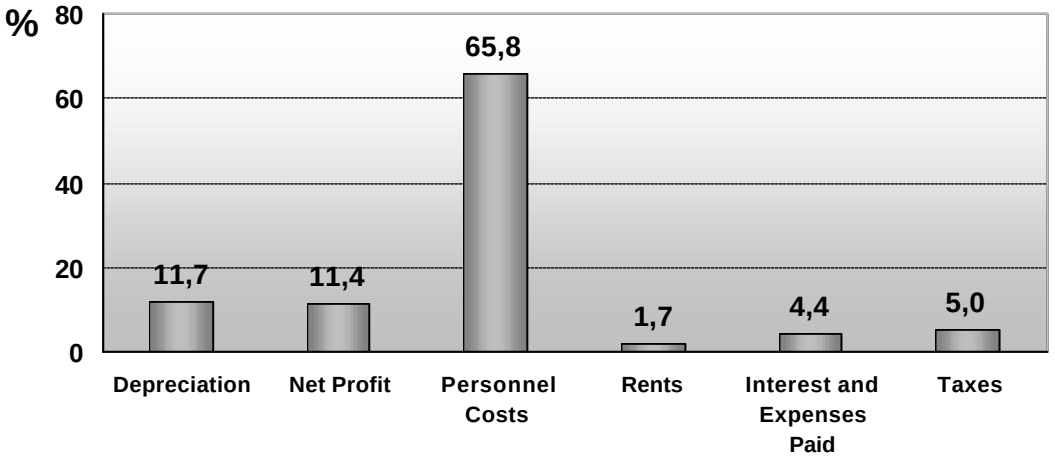

Figure 4 - Value Added distribution in big Brazilian software companies (more than 100 employees)

4. CONCLUSION

The cover story in Business Week/December 6, 1999 (38-44) has the title "Software Hell: Glitches cost billions of dollars and jeopardize human lives. How can we kill the bugs?". On the page 44, in a box entitled "Will bugs eat the U.S. Lead in Software?", there is the following recognition: "Both India and Brazil are mounting intensive campaigns to nurture a world-class software industry. Their competitive advantage will be quality [...]".

Brazil is effectively looking for the achievement of international standards on quality and productivity in the software sector and there are available national databases of software quality information based on MCT/SEPIN's surveys (http://www.mct.gov.br) that confirm continuous improvement. This paper presents the main findings of these Software Quality surveys.

SOFTEX's surveys (http://www.softex.br), made by the Internet in the U.S., Europe, and Brazil in 1997 and 1998, show quality ranked among the best attributes of the Brazilian software products.

But there was a lack of software productivity information in Brazil, mainly those related to the productivity of the Brazilian software industry, as stressed by Weber and Amaral (1999). In this sense, this paper presents an innovation in the 1999 Software Quality and Productivity Survey – there were also collected data to assess the Systemic Productivity (SP) of the Brazilian Software industry and its main results are available on it.

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