Industrial Performance Assessment Through the Application of a Benchmarking and Monitoring System

Marcos Ronaldo Albertin, Heráclito Lopes Jaguaribe Pontes, Enzo Morosini Frazzon and Enio Rabelo Frota

Abstract The purpose of this paper is to describe a multiple criteria benchmarking and monitoring system for assessing the performance of industrial sectors. The referred system was designed for comparing and monitoring companies' performance against market requirements. As an illustration, data collected during a three-year period for a specific local productive arrangement of Ceará, Brazil are showcased. The findings indicate the opportunities and needs for collective strategic actions by the companies and sectors in order to promote local development.

Keywords Bechmarking · Industrial performance · Local develpment · Information systems

Introduction

During recent decades, changes promoted by globalization have highlighted companies' inabilities to internally obtain the competences needed for surviving. As a consequence, the relationships with other companies are no longer seen just as market transactions, but rather as opportunities to gain complementary assets, technologies and competences. Thus, there is a rapid growth in inter-firm relationships such as collaborative networks and supply chains. For instance, organization in clusters has been intensively studied in academic literature (Lehtinen and Ahola 2010). In this paper, this kind of organization is referred to as local pro-

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ductive arrangements (LPAs). Hon (2005) describes the different kinds of manufacturing systems as single machine, group of machine (cell, line), supply chains and production networks. This paper focuses on the interaction of local actors as suppliers in supply chains and their quest for competitive advantages through collaboration in productive arrangements (PAs). According to Polenske (2004) many analysts assure that companies can meet the challenges of global competition by establishing improved competitive or collaborative activities. For Balestrin and Verschoore (2008) the competition–cooperation dichotomy marks the relationships between organizations today. The analysis of different PAs and their collective and individual performances represents a good opportunity to research, because there has been little exploration about integrated development actions in supply chains. For the performance analysis, a metric system is necessary. The literature on this subject of performance assessment emphasizes intra-organizational measures, which conflict with the emphasis on inter-organizational collaboration, which is dominant in the literature addressing, extended enterprises (Zhou and Benton 2007). Albertin et al. (2010) developed a computational system to share information in a competitive and collaborative environment using an Internet benchmarking methodology called Benchmarking and Monitoring System of Productive Arrangements (SIMAP). Effective benchmarking requires standards or criteria for measuring performance across the broad range of organizations. SIMAP measures the relative performance levels of similar operations or activities from local or interconnected organizations. It shows individual and collective gaps and local development opportunities.

Benchmarking is defined by Xerox as a continuous and systematic process of evaluating companies recognized as industry leaders, to determine business and work processes that represent best practices and establish rational performance goals (Camp 1989). Analysing the evolution of benchmarking, Kyrö (2003) proposes a new and more complete definition: "Benchmarking refers to evaluating and improving an organisation's, its units' or a network's performance, technology, process, competence and/or strategy with chosen geographical scope by learning from or/and with its own unit, other organisation or a network that is identified as having best practices in its respective field as a competitor, as operating in the same industry, cluster or sector or in the larger context with chosen geographical scope" p. 222.

Thus, benchmarking can be sector-, region-, supply-chain- or global-based. Benchmarking studies can provide several benefits (Zhou and Benton 2007): (1) Allowing companies to learn from others' experiences; (2) helping companies to analyse their own levels of performance relative to the competition; (3) identifying the companies with the highest (or lowest) levels of performance and studying them to gain insights into the activities that correlate with high (or low) performance. Inter-firm knowledge sharing and learning improve supply chains' performance in today's business environment. It is important to highlight that benchmarking does not automatically provide a solution. The organization still has to find the right measures for comparison, analyse the causes for performance gap and search for innovative solutions. The main objective of this paper is to describe a multiple criteria benchmarking and monitoring system for assessing the performance of

industrial sectors. It should evaluate PAs and propose actions to benefit not only a singular enterprise but a group of enterprises. The concept and methodologies of Internet benchmarking are presented. As an illustration, data collected during a three-year period for a specific local productive arrangement of Ceará/Brazil are showcased.

Benchmarking and Monitoring System (SIMAP)

The SIMAP is an interactive benchmarking tool created to help companies, developing agencies and policy makers to identify challenges and opportunities for improving their performance. Through a significant sample of collected data, the system allows for a more productive dialogue among government and companies, based on information updated dynamically, avoiding inefficient and unfocused actions. To sum up, a company can compare itself with the average of the registered companies, in the state and country where they act. It can also identify benchmark companies, which are reference of efficiency (performance) and effectiveness (results) to other companies that belongs to the same link (have the same process). Besides systemic competitiveness SIMAP's proposal is supporting action at the meso-level (Messner 1996; Altenburg et al. 1998). It was originally developed to promote the development of the automotive industry of the state of Rio Grande do Sul (RS-Brazil), and now is being used as a tool to increase the supply of local content in many regional PAs in the state of Ceará (Albertin 2003).

Some fundamental features of the system include: possibility of dynamic feeding an online database surveying information on 46 criteria that are grouped into seven subsystems as follows: Integrated Management System (GP01), Production Management (GP02), Products Management (GP03), Strategic Management (GP04), Logistic Management (GP05), Human Resources Management (GP06), and Financial Management (GP07) as shown in Fig. 1. The first subsystem GP01 has five criteria as shown in Appendix A. Each criterion has a growing performance metric adapted from Likert scale of five levels (0, 25, 50, 75 and 100), featuring categorized qualitative data. These criteria represent performance and best practices. For example, the criterion "ISO 9001" can only be answered with: NA (not applicable), 0 % (informal procedures), 25 % (documented procedures), 50 % (formal program development), 75 % (performs internal audits) and 100 % (company certified). The criteria and performance levels derive from the requirements established in the Malcolm Bridge Award, as well as in the Toyota Production System, ISO /TS 16949 and ISO 9001. Each subsystem was set based on interviews with companies and professionals to identify the most important tools. A minimal or desirable performance (requirement) to delivery to a focal company was identified for each PA. The data was collected by interviews, technical visits and mainly by Internet. As a method to analyse the collected dates we are using: (a) bars graphics and means and (b) individual and collective visual gaps analyses. The performance of a company (bar chart) and the mean comparison of performance in

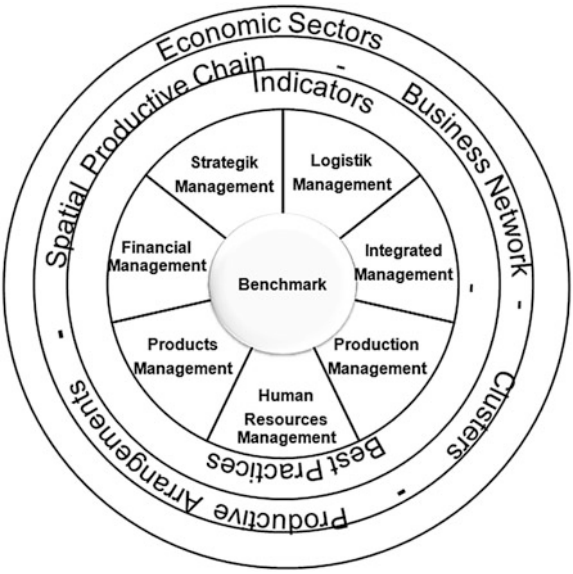

Fig. 1 Application of SIMAP

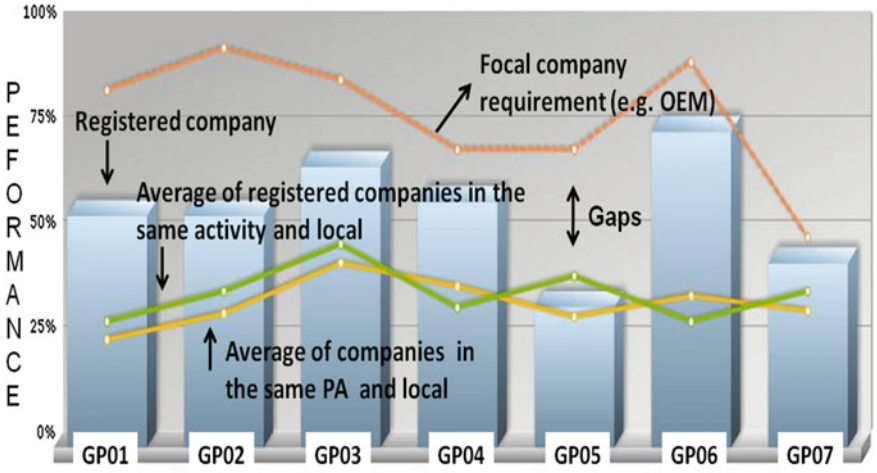

Fig. 2 Individual performance (*Bars*) and the average performance (*Line*)

the GP01 to GP07 subsystems of all registered companies on the local automotive supply chain in the State of Ceará are observed in Fig. 2.

The system architecture of SIMAP, which was adapted from the work of Johnson et al. (2010), is represented in Fig. 3. The represented architecture aims to show what we have described above. SIMAP aims to provide an online

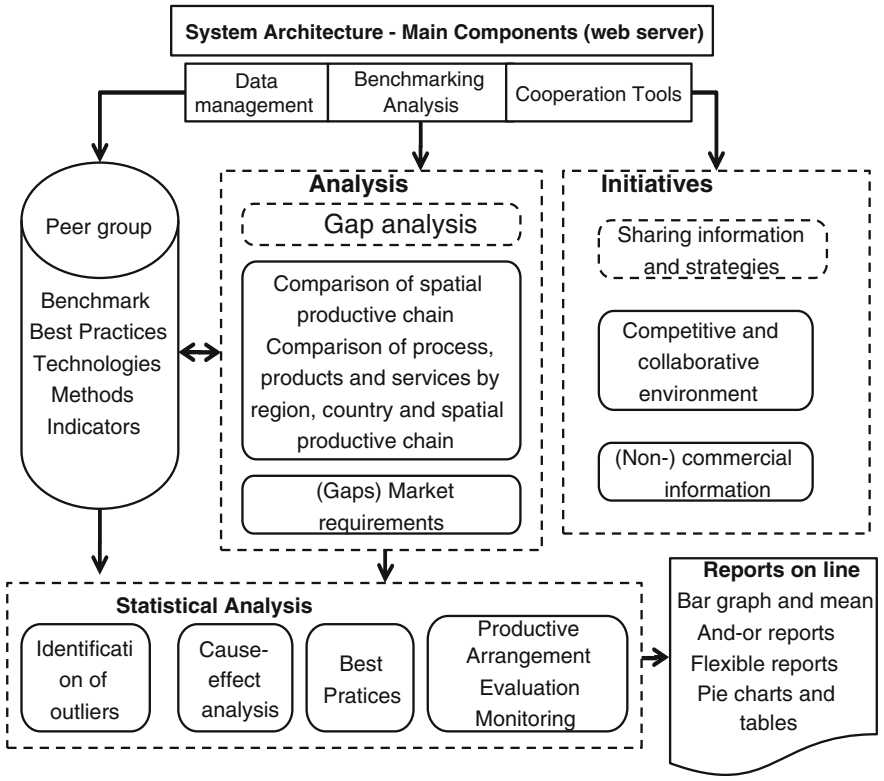

Fig. 3 SIMAP system architecture (Adapted from Johnson et al. 2010)

benchmarking analysis that addresses the need for the performance assessment tools mentioned above.

With this innovative tool any firm with Internet access can participate and view the individual performance analysis results in real-time. It is observed that the inclusion of data in SIMAP occurs with the indication of the location, which can be territorial state, region or country, as represented in the axis "territory" in Fig. 4.

This figure illustrates the possible comparisons in SIMAP. The axis "activities" provides the benchmarking by activity (link) of companies compared to other links of the same or different PA. It is possible, for example, for a machining company to compare itself with the average performance of other states and countries, and with its direct competitors in the same PA (territory) or in the same country. It is possible to draw a value chain, a supply chain, cluster or other types of productive arrangements (PAs), and make restricted or unrestricted access comparisons. A total of 285 entries were made in Ceará companies operating in 18 production chains. Supply chains with more registered companies are metal-mechanic (56), construction (49), automotive (35), textiles and clothing (30) and food and beverage (23).

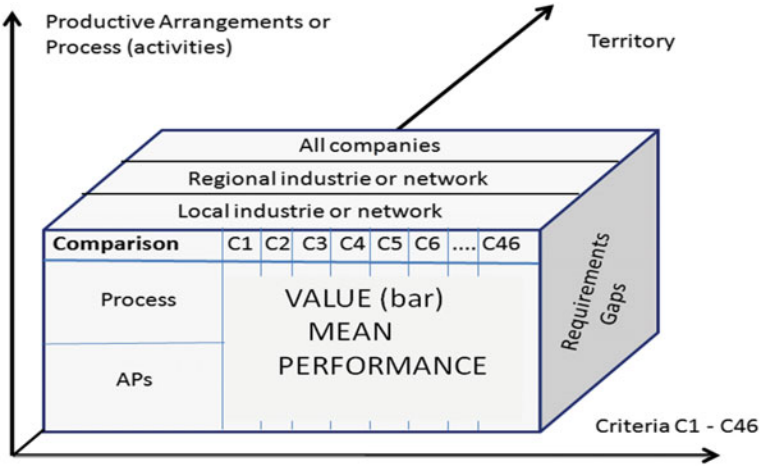

Fig. 4 Possible comparisons on SIMAP

Industrial Performance Assessment

In this section we present results and analysis of the study. The graphs were generated from SIMAP with the database of June/2012. The average performance of firms by size in Ceará is shown in Fig. 5. It can be observed that the average performance of large companies is around the range of 50–75 %, the performance of medium-sized companies is close to 50 %, while the performance of small businesses oscillates around 25 %. The range of 25 % indicates an effort towards the formalization and standardization of processes. The overall performance of all companies from Ceará registered in SIMAP is represented by the 3rd line (overall average) in the range between 25 and 50 %.

The automotive (AUT) sector is very competitive and dynamic. The requirements to provide this chain led by major automakers are globalized and were based

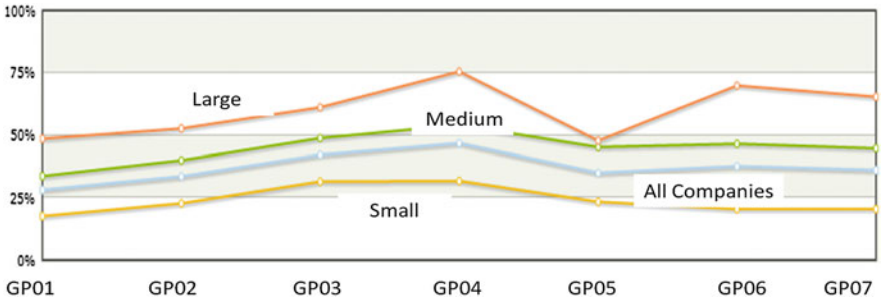

Fig. 5 Average performance by size in Ceará

on the ISO/TS 16949. In Ceará, cars of the types Jeep and Buggy are manufactured in small quantity and auto parts. In 2007 the automotive factory of Troller Special Vehicles was merged into Ford Motor Company, creating new challenges for the local supply chain. In Fig. 6 we see that the benchmarking company performance (bar graph) is much higher than the rest of this AP.

The differences between the performance (continued line or bar graph) and industry market requirements (dotted line) are called bottlenecks or gaps. As shown SIMAP allows viewing "online and on time" gaps for any company registered for free. Gaps are considered technical barriers to supply the local production chain. The gaps in the criteria subsystems Integrated Management (GP01) and Product Management (GP03), by company size, are represented in Figs. 7 and 8. Legends can be found in the Appendix.

It is observed that there are gaps in all sizes of company, for the criteria C1 through C5, and that they are larger for small businesses. The certification to international standards ISO 9001 (C1) is not implemented yet in most of the state.

Figure 8 shows the gaps of Production Management subsystem (GP02). The gaps for the criteria C6 through C15 are smaller for medium and large companies

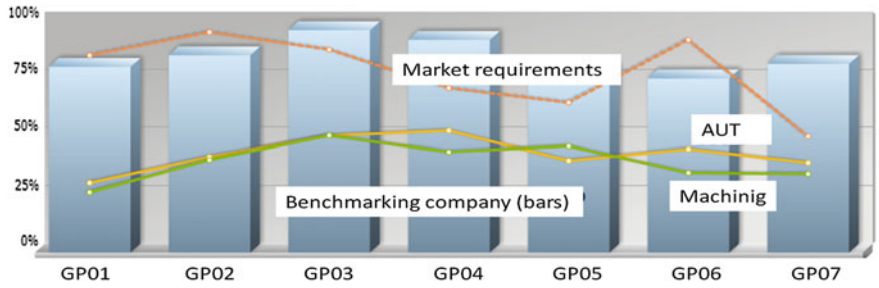

Fig. 6 Company "benchmarking" and automotive PA

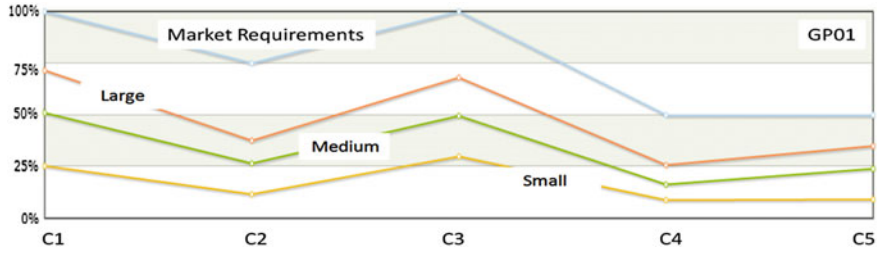

Fig. 7 Gaps for the automotive PA (AUT) considering the subsystem GP01

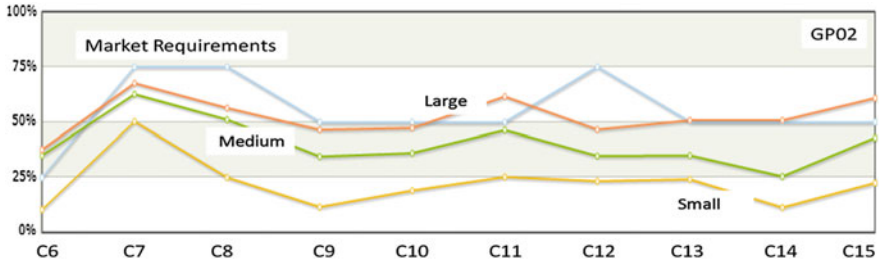

Fig. 8 Gaps for the automotive PA (AUT) considering the subsystem GP02

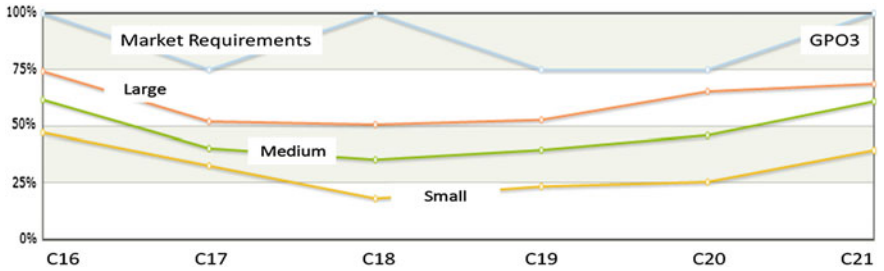

Fig. 9 Gaps for the automotive PA considering the subsystem GP03

and significantly large for small businesses. The gaps are larger than the criteria capability studies (C8) and maintenance (C12) (Fig. 9).

The Product Management subsystem chart above is comprised by the criteria gaps for C16–C21. The highest development of products and processes through functional teams is in the criterion C18. It is observed that the requirements to provide the automotive industry are equal for any company, regardless of size. The small-sized companies work with informal procedures, which are not documented, and its processes are shown to be unstable.

Discussion

The purpose of this paper was to describe a multiple criteria benchmarking and monitoring system for assessing the performance of industrial sectors. After three years of data collection, the average performance of 285 companies was presented using 46 criteria, which display best practices and performance indicators. The performance analysis was segmented by small, medium and large-sized companies,

comparing: (i) the average performance of these groups of companies separately, (ii) the performance of the "Benchmarking Company" and (iii) the minimum supply requirements that are requested by leading companies in the PAs. As an illustration, data collected for a specific automobile AP of Ceará, Brazil was showcased. The findings indicate the opportunities and needs for inserting the Ceará companies in supply chains led by large local companies operating or being installed in the state, considering the use of best practices found in globalized production systems. It was observed that there is a big difference in the use of best practices between the small and medium/large businesses. The average performance of Ceará small businesses indicates that they are in transition to standardization for Quality and Process Control. The processes of small businesses are unstable and they generate excessive costs with control, rework and scrap. The average performance of small-sized companies (1–99 employees) falls short of most supply requirements of regional or national leading companies, but it can be improved by benchmarking of companies that stand out. The benefit of SIMAP system is to promote individual and collective actions those impacts on an AP. The following information could be obtained online: (a) individual performance in 46 criteria and their 7 subsystems with the Likert scale (0–25–50–75–100 %); (b) average performance of companies registered in the same PA, or even in the same activity or in the same territory; (c) individual and collective gaps analyses and (d) visualizationof competitive positioning after some actions.

Appendix A

See Tables 1, 2 and 3.

Table 1 Integrated management system (GP01)

GP01	0	25	50	75	100
C1. ISO 9001 C2. ISO 14001 C3. 5S C4. SA 8000 C5. OSHAS 18000	Informal procedures	Documented procedures	Formal program deployment	Conducts internal audits	Certificated

Table 2 Production management (GP02)

GP02	0	25	50	75	100
C6. Setup time	Informal procedures	Documented procedures	Time < 60 min	Time < 40 min	<10 (SMED)
C7. Production planning and control (PPC)	Informal procedures	Electronic sheets (Excel, Calc, etc.)	Software	MRP and MRP II	ERP
C8. Capability studies	Informal procedures	Instable process	Stable process	CEP	Cpk > 2
C9. Quality costs	Unknown	Monitors	1–10 % revenue	<1 % revenue	<0.5 revenue
C10. Process control	Informal parameters	Formal parameters	Monitored parameters	Calibrated instruments	Capability studies
C11. Part per million (PPM)	Unknown	Known	1–10 %	<1000 PPM	<500 PPM
C12. Total preventive maintenance	Corrective	Maintenance plan informal	Preventive	Predictive	TPM
C13. Just in time	Not use tools	One tool	Two tolls	Three tools	Many tools
C14. Suppliers development	Informal procedures	Formal procedures	Monitors performance	Training programs	Establishing partnership
C15. Average age of equipment	Unknown	More than 20 years	Between 10 and 20 years	Between 5 and 10 years	More than 5 years

Table 3 Products management (GP03)

GP03	0	25	50	75	100
C16. Use of technical norms	Unknown	Knows and use partly	Uses the main	Always use	Uses 100 % and update
C17. CAD–CAE-CIM	Unknown	Known	Uses CAS	Uses CAD e CAE	Uses CAD-CAE-CIM
C18. Multifunctional groups	Doesn't perform	Uses informally	Documented procedure	Implemented	Always uses
C19. Time to market	Doesn't control	Informal control	Monitor	Competitive	Is benchmark
C20. Methodology for development of new products	Unknown	Informal	Documented	Continually improve	Concept uses of lessons learn
C21. Suppliers and customers partnerships	Doesn't perform	Informal	Formal	Suppliers	Suppliers and clients

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