

In this section we describe the technological state of Brazil . First we give a brief overview of developments in Brazilian high-tech sectors, after which we discuss the current state of research and development. After this, we present an overview regarding the diffusion and usage of relatively old technologies like the internet and telephone, and the degree of innovation. At last we provide a complete comparative table , which should give a quick overview of the differences between Brazil and the Netherland.

DEVELOPMENTS

Overview of Brazilian high-tech

High-technology (or advanced technology) manufacturing is characterized by the relatively high amount of Research & Development (R&D) involved. Examples of high-tech products Brazil manufactures are automobiles, medicine, aircrafts, software, fiber optics, electric appliances and so on. High-technology sectors in Brazil include the following:

- **Aerospace.** Brazil has been active in aerospace since 1950. Its space program is mainly being used for earth observation (i.e. for agriculture, environment, natural resources) and for scientific research (British National Space Centre, 2003). Some disastrous events occurred in the 2000's, however in 2006 Marco Pontes was the first Brazilian who went into space. Also, the government has plans for launching a satellite rocket in 2011 (www.space-travel.com, 2008).
- **Biotechnology.** Brazilian biotechnology (technology for food processing, biofuels like ethanol, biomass et cetera) is well-developed and is still developing. Because of the large amount of natural resources Brazil has, it is often seen as a great opportunity for the country.
- **Energy/nuclear.** Since 2006, Brazil has been energy independent. Main sources of energy are oil, hydropower and natural gas. Brazil has two nuclear power plants providing 3% of its total electricity. Brazil has plans to build another nuclear power plant in 2014. Furthermore, Brazil is the leading country in deep-water oil exploration technology and in the production and use of renewable energy sources, like ethanol (Sennes, sd).
- **Nanotechnology.** Less developed countries like Brazil are often overlooked when it comes to activities in nanotechnology, even though there are some developments in this field (Malsch, 2008). Most Brazilian nanotechnology research is focused on aerospace, agribusiness, cosmetics, health, energy, the environment and textiles (Malsch & Valenzuela, 2008).
- **Telecommunication/ICT/Electronics.** Brazilian software is considered high-quality and Brazilian software developers are known for their efficiency and quality. In the 1980s, the national market did expand and several innovations in ICT products took place. Due to the protectionism policies Brazilian companies however were not able to compete with the world market, because the rest of the world grew faster, causing the Brazilian technological innovations to antique. Sennes (sd) argues that this is because Brazil has no iconic company that has mastered a key technology. Moreover, Brazil does not successfully publicize its efforts and accomplishments.

Current issues

Most technological issues are a result of the protectionism policies of the 1980s. Brazil is growing, but it does not grow as fast as other developing countries like China and India do. First, there's the large technological gap with developed countries. Second, there's the difficulty to innovate, because of inconsistencies in intellectual property (patents) regulations. Third, the academic world and the business world need to work together, to innovate and create tangible products, processes or services. The export of Brazilian high-tech products is no more than 13 per cent of total export, produced by just a few companies. According to Sennes (sd) this indicates the need for adoption of innovation policies.

The Brazilian government works hard to solve these issues and to achieve and stimulate technological innovation. Some policies and laws have been enacted, making it easier to request patents. These include for example the Industrial, Technological and Foreign Trade Policy (PITCE), the Innovation Law and the Good Law.

Speed of technology transfer

We describe technology transfer as the process of applying scientific knowledge into tangible products, processes or services. These newly created products are registered in the form of patents. In the last three decades, Brazil has multiplied its patents from 24 in the year 1980 to 121 in the year 2006 (Nicolisky, 2007).

Most of these patents are from abroad. Research by Prospectiva Consulting showed positive developments: the amount of patents filed in the period 2004 to 2006 for a Brazilian pharmaceutical company was 76, compared to a number of 97 from 1990 to 2003. However, in comparison to other developing countries like China, Brazil still lags behind in this development (Sennes & Mendes, 2008).

RESEARCH AND DEVELOPMENT

In this paragraph, we describe the state of research and development (R&D). Research and development covers three activities: basic research, applied research and experimental development.

Expenditures in R&D

A definition of the expenditures in R&D:

“Expenditures for research and development are current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture and society, and the use of knowledge for new applications. R&D covers basic research, applied research and experimental development.” (World Development Indicators database, 2004).

In table 1 the expenditures of Brazil are compared to the USA, the Netherlands and China. The figures are a percentage of the gross domestic product.

Year	Brazil	USA	Netherlands	China
2000	0.99	2.74	1.82	0.9
2001	1.02	2.76	1.80	0.95
2002	0.98	2.65	1.72	1.07
2003	0.98	2.68	1.76	1.13

Table 1: expenditures in R&D as % of GDP (OECD factbook 2007)

The values of the USA and the Netherlands are very high compared to Brazil. The expenditure of China is in the same range. It is also interesting to look at the absolute numbers of the expenditure in R&D. In 2003 Brazil and the Netherlands had almost the same GDP (Both a GDP of over 500 billion) so it would not really make a difference to focus on absolute or relative numbers when comparing these two countries.

Technology achievement index

The technology achievement index (TAI) is an index which measures the technological state of a certain country. This index is calculated using four components: the creation of technology, diffusion of recent and old innovations and human skills.

Country	Brazil	USA	Netherlands	China
TAI value	0.311	0.733	0.630	0.299

Table 2 :TAI value (Desai, M., Fukuda-Parr, S., Johansson, C. and Sagasti, F. 2007)

Compared to the Netherlands and the USA, Brazil has a low value. The value of Brazil is in the same range as the value of China. The differences are almost the same with the R&D expenditures, where the western countries had a higher score and Brazil and China scores almost the same also.

These TAI values do not give an insight in the technological potential. This is also the case with Brazil. It has two world class technology hubs and it is in the forefront of policy initiatives in global areas such as the management of intellectual property, but Brazil lags behind with the diffusion of the new and the old technologies. Therefore it has a relative low value for the technology achievement index, 0.311, with a 43rd place on the world ranking list.

TECHNOLOGY

In this paragraph, we will discuss and compare the internet and telephone usage in Brazil with other countries. Further we will cover innovation in the technological sector of Brazil.

Internet

In the last couple of years the internet usage of the Brazilian people has increased significantly. According to “Internet World Stats” the percentage of the population that has access to an internet connection has risen from around 3% in the year 2000 to almost 35% in 2008. In June 2009 around 10.000.000 Brazilians had access to a broadband internet connection, which is around 5.1% of the total population of Brazil. This percentage is much lower compared to the Netherlands, there were around 5.5 million broadband subscribers in June 2008. This is around 33.1% of the total Dutch population. (note: this is not the total amount of users that has access to the internet) (World Internet Stats, 2009).

country	USA	NL	Brazil	China
population	307,212,000	16,716,000	198,739,000	1,338,613,000
internet users	231,000,000	14,273,000	64,948,000	298,000,000
% of population	75.2%	85.4%	32.7%	22.3%

Table 1: internet usage in 2008 compared with other countries (C.I.A., 2010)

Telephone

Brazil has a good working land line system, but the amount of fixed line connections has remained relatively stable in the recent years, around 20 per 100 persons. This number has been stagnant or even decreasing, in favor of cellular phones. Due to the fact land lines are relatively expensive, more and more people are switching from land lines to mobile phones, or starting at the mobile phone market. Also the fact that mobile phones are very easy to acquire compared to the relatively high costs for the installation of a land line telephone system, makes people switch.

Around 75% of Brazils population has a mobile phone. This number has more than tripled over the last 5 years. The biggest change in the field of mobile services occurred in 2001 when a plethora of small regional companies. Consolidated into nine operators, four of these hold over 92% of the mobile market. (C.I.A., 2010), (World Internet Stats, 2009).

country	USA	NL	Brazil	China
population	307,212,000	16,716,000	198,739,000	1,338,613,000
# land lines	150,000,000	7,324,000	41,141,000	365,600,000
% of pop	48.8%	43.8%	20.7%	27.3%
# cellular phones	270,000,000	19.927,000	150,641,000	634,000,000
% of population	87.9%	119.2%*	75.8%	47.4%

Table 2: overview of phone usage in 2008 (C.I.A., 2010) * means 1.2 cell phone per inhabitant

Degree of innovation

The degree of innovation of a country is based on inputs and outputs. In total there are 7 factors that influence the score of a country on the Global Innovation Index. Brazil takes the 50th place on the list of 130 countries in the overall rankings. On the input pillars raking, Brazil is on the 54th place while on the output pillars putting Brazil is on the 39th place on the list. (INSEAD, 2009)

country	USA		NL		Brazil		China	
	score	rank	score	rank	score	rank	score	rank
overall	5.28	1	4.64	10	3.25	50	3.59	37
input	5.72	2	5.31	12	3.64	54	3.85	47
output	4.84	1	3.96	8	2.86	39	3.33	29

Table 3: innovation index, according to (INSEAD, 2009)

Comparative table

Table 7 presents comparative table with the differences between Brazil and the Netherlands. In this table different values of the previous paragraphs are incorporated for an easy comparison.

	Brazil	Netherlands
TAI value []	0.311	0.630
R&D expenditure	0.98	1.760
internet users	64,948,000	14,273,000
% of population	85.40%	32.70%
# land lines	41141000	7324000
% of population	20.7	43.8
# cellular phones	150,641,000	19,927,000
% of population	75.80%	119.20%
innovation index rank (INSEAD)	50 th	10 th
innovation index score (INSEAD)	3.25	4.64
innovation index (BCG/NAM/MI)	72	12

Table 7: comparison between Brazil and the Netherlands

This table clearly shows differences between the Netherlands and Brazil. The fact that Brazil scores lower on the Technology Achievement Index (TAI) and on the Innovation Index(es) also reflects on the number of (mobile) telephone subscribers and the number of internet connections. Although it has to be said that this gap gets smaller, because there is a real boost in the number of (broadband) internet connections and the number of cellular phone subscribers.

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