

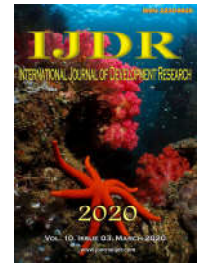


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AGROINDUSTRIAL TECHNOLOGY IN BRAZILIAN AWAKENING TO CRAFT BEERS

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ABSTRACT

The Brazilian brewery sector has significantly grown in the past few years due to recent developments from microbreweries and mid-scale craft beer manufacturers. Despite the slightly higher end-product cost, the diversity and improved quality are perceived as an acceptable trade-off by customers. The contemporary Brazilian scenario contrasts with the legacy mainstream beer producers that prevailed in market-share until late 90s with no competitors. In this article, we present a brief introduction of the beer history worldwide and its current state in Brazil. The ongoing revolution in Brazilian brewing, and the consequences of an improved production chain in the agrarian sector are contextualized according to each beer ingredient. All the local specificities related to barley and hops in Brazil are discussed according to our new societal needs. We further elaborate on the rise of craft beers in the Brazilian market and their positive economic impacts aided by local brewer strategies to appeal to a broader audience.

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INTRODUCTION

Historical context and Brazil in the brewing market

Beer is the most consumed alcoholic beverage in the world and quite as well considered a national passion in Brazil. There is even an International Beer Day, which happens every first Friday of August, that is completely dedicated to celebrating the act of producing and drinking beer. The history of such golden beverage, appreciated by many, has arisen long ago closely linked to agricultural advances. Fermented foods and beverages have significantly influenced societies through history (Legras *et al.*, 2007). Archaeological evidences suggest that the production of fermented beverages is as early as 7,000 BC in China, 6,000 BC in Iran and 3,000 BC in Egypt (McGovern *et al.*, 1997; Cavalieri *et al.*, 2003; McGovern *et al.*, 2004). The oldest evidences are related to the fermentation of rice, honey and assorted fruits (McGovern *et al.*, 2004), as

fermented grain-based beverages artifacts found by archaeologists are as old as the mammoths' extinction in the fourth millennium BC (Meusdoerffer, 2009). Brewing as a source of food already occurred in early Mesopotamia according to historical records and old manuscripts. The best-known evidence is the "Hymn to Ninkasi" written by a Sumerian poet in 1,800 BC on a ceramic tablet, depicting one of the earliest brewing recipes ever found (Civil, 1964). Beer and other alcoholic beverages caused a 'state of ecstasy' that was considered by the past civilizations as a spiritual exercise of communion with divinities. Therefore, beer served as an offering to their gods, which was believed to be an essential constituent of their divine diet. At that time, diseases were believed to be a sign "divine anger", hence requiring a magic ritual of sorts that involved beer consumption. Beer consumption was, at the dawn of civilization, an ingredient of ancient medical therapies. It is no wonder that beer claimed its societal importance as a basic element of medications, due to its magical evocation properties of the past (Meusdoerffer,

2009). Beer, malt and “beer bread” were also a common element of tributes and tithes. Beer-related products were part of the daily remuneration of magistrates, servants, priests and workers. The brewing ingredients as well as the entire beer manufacturing processes have varied drastically since then, by constantly improving through millennia up to the current brewing methods (Hartman, 2013).

The brewing method was an early technological achievement that considerably preceded the Sumerians in Mesopotamia. Such technologies may have led to the development of modern human society, which ultimately caused the “Neolithic Revolution” (Damerow, 2012). However, grain cultivation did not spread to northern Europe until the Neolithic period, about 6,000 years ago. Hence, a distinct brewing tradition emerged at that territory in relation to Mediterranean civilizations. The most known countries in beer production are located in Europe. Even though brewing techniques from early German tribes have not been well documented, it is known that these communities prepared a barley or wheat liquid that resembled “rotten” wine. Archaeological evidence also indicates that germination of cereals (malting) was a huge step towards Germanic manufacturing (Grüß, 1931). Considering their fermentation process, the first beers were generally “high fermentation” or ale styles. Lager beers were conceived much later in 16th century (Galet, 1977). Nowadays, the Brazilian legislation defines beer as a “beverage obtained by alcoholic fermentation by yeast action of a wort containing barley malt, potable water and hops”. Brazilian law still allows the substitution of barley malt by adjuncts, whose use may not exceed 45% in relation to the original extract (Brasil, 2009). Brazil consumes 68 L of beer per capita per year (LIY). This amount is far below to Czechs or Germans who consume 143,000 and 106,000 LIY, respectively. However, Brazilians stand out in South America in beer consumption, since Chileans (46 LIY), Argentines (47 LIY) and Uruguayans (30 LIY) consumption data reveals a much lower average intake of beer products (Marcusso and Müller, 2012).

In 2018, global beer production was about 191,1 billion liters, showing an increase of 0.6% from the previous year. Brazil produces about 14,1 billion liters per year (bLY) as the third country in the world ranking, which is currently led by China (38,9 bLY) and followed by USA (21,4 bLY). Among the top five world’s largest beer producing countries are Mexico (11,9 bLY) and Germany (9,3 bLY) (Kirin Beer University, 2019). The Brazilian potential in beer industry sector follows the regulations in Decree n° 6.871 of 04/06/2009 from Ministry of Agriculture, Livestock and Food Supply – MAPA (Brasil, 2009). The proper regulation provides standardization, classification, registration, production and inspection of all beverages produced in the country (Legras, 2007). It also establishes sanitary conditions, quality standards and technological definitions employed by alcoholic beverage industry (Portal Brasil, 2017; Marcusso and Müller, 2012). The beer industry in Brazil faces a high demand and an ever-increasing demand that went from 5.2 bLY in the past ten years, thus reaching a 64% growth (13.4 bLY) (SEBRAE, 2013). According to Kirin Beer University (2019), Brazilian production showed 36.7% of growth from 2008 to 2018, representing 3,7 bLY of beer. The year of 2018 brought many new breweries to Brazilian beer scenario, as well as a new regulation on the registration of establishments and products in MAPA. Brazilian Normative Instruction No. 72 of November

16th 2018 have been provided more agility in the product registration processes and the advance of self-control by producers. In the same year, around 6,800 beer product registrations were granted. According to Melz (2019), there are currently more than 1,100 Brazilian breweries that manufacture 16,968 products. Recently, cans surpassed bottles and now accounts for more than 50% of beer bottling (ABRALATAS, 2019). Accordingly, brewing is one of the most relevant sectors in Brazilian economy as it reveals a high potential of socioeconomic and technological growth. Brazilian beer industries have had approximately USD 6.1 billion investments between 2011 and 2014 with 2.2 million employees. Annually, about 2.7 million jobs are linked to beer market (CervBrasil, 2018). Despite the large number of employees, the beer industry is the 12th sector with open job positions in the country (CervBrasil, 2014). This enormous economic impact of beer is demonstrated by the USD 8.2 billion paid in wages and USD 6.4 billion collected in annual taxes (CervBrasil, 2014). Its revenue has a significant contribution (2.0%) to the national Gross Domestic Product (GDP), moving USD 23.5 billion per year (EBC, 2019). This growth rate reflects directly into Brazilian agribusiness by increasing demand for inputs such as raw materials. According to the “Brazilian Association of the Beer Industry” (CervBrasil, 2014), the country has about 117 thousand hectares of cereals for beer production managed by 11 thousand families in rural areas working for meeting this demand (Marcusso and Müller, 2012).

Brazilian craft beers

A significant improvement in Brazilian brewery market is due to the impact of recent craft beers. Despite the slightly higher cost paid by the consumer, the variety and quality of these products have attracted the public in comparison to mainstream beers that dominated commerce in Brazil until 1990s (Lopes *et al.*, 2017). This correlation reveals the good timing of craft beers in the market, which provided new alternatives and diversity to consumers. Mainstream beer brands, however, have been demonstrated approximately 2% of annual decrease in their sales. Nevertheless, Brazil produces 91 million liters of craft beer per year, representing only 0.7% of the total beer volume sold in the country (Ferreira, 2017). But MAPA has been registering an increase in the number of breweries every year, which provides a favorable scenario where Brazil may soon repeat American microbrewing history (Portal Brasil, 2017). Argentina and Uruguay, for example, already have more than 1.0% market share for craft beers while USA has already surpassed 12% (Bressiani, 2017). The craft beer awareness in Brazil follows a similar trend that was observed in the USA at the end of the last century, and now represents 3.0% of the Brazilian beer market (Dias and Falconi, 2018). Nowadays, the American market is already consolidated with several mid-sized craft breweries. On the other hand, the Brazilian model has been concentrated on small craft breweries that sell, on average, 20,000 liters per month (Ferreira, 2017). An expressive increment of craft microbreweries is shown in Figure 1 comparing Brazilian and American markets, where a similar pattern can be observed between these two countries. In fact, the number of Brazilian facilities is about the same of American microbreweries in 1994. Four years later, this number tripled in North America (Ferreira, 2016; Bressiani, 2017; Moir, 2000).

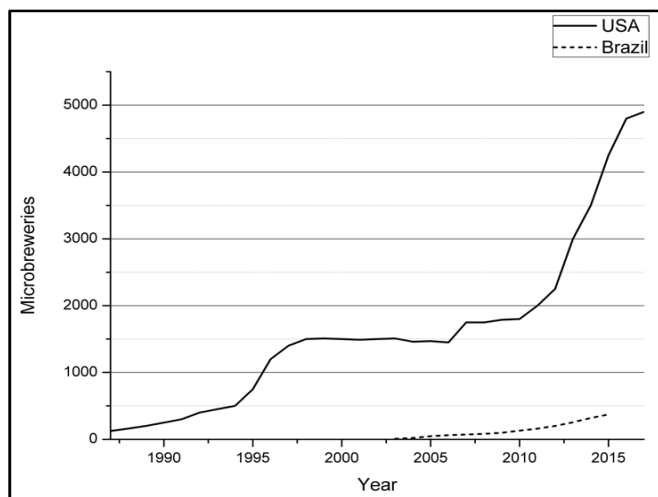


Figure 1. Comparison of craft breweries number in Brazil and USA over last three decades

There are no consistent numbers about the microbreweries in the early 90s, but it is known that Brazil has exponentially increased its production. There are more breweries in Brazil nowadays than at any point of its history. A particularly rapid growth has been observed in recent years with the foundation of a new microbrewery per week since 2010 (Ferreira, 2016). Nowadays, this rate has increased to a new brewery every two days (Marcusso and Müller, 2019; CervBrasil, 2019). This impressive rise in businesses occurs even when the Brazilian market encounters a recession since 2016 (Bressiani, 2017). Moreover, there is no indication that this development will cease in future. All datasets analyzed by IBGE (2017) do not take into account breweries in the planning stages though. The microbrewery growth pattern observed in American and also in European can be expected if prominent progress in the Brazilian beer industry continues, causing brewery numbers to double every two years, as showed by Table 1 (Watson, 2014; Hadi, 2015). In Brazil, this number was 372 in 2015, 520 in 2016 (Ferreira, 2016), 679 in 2017 and 889 in 2018 (Melz, 2018), which represents successive growth rates equivalent to 17.0%, 39.8%, 30.6% and 30.9%, respectively, when compared with the previous year. In total, from 2007 to 2018, the number of Brazilian craft breweries increased 1,832.6% (Ferreira, 2016; Melz, 2018; Marcusso and Müller, 2019). Although 2019 data weren't published yet, Brazilian perspectives for 2020 regarding artisanal breweries are very promising. There were 889 registered breweries in 2018, corresponding to 210 new registrations granted this year. This recent development has already surpassed last year's indicators by 30.9%, which is remarkable because shows how craft beer is gaining market in Brazil (Marcusso and Müller, 2019; CervBrasil, 2019). As for the geographical distribution of producing regions, 83,8% of the breweries are in the South (43,2%) and in the Southeast (40,6%). This interestingly mirrors the wealth concentration in the Brazilian territory, where the most developed cities are found (Ferreira, 2016; Marcusso and Müller, 2019). Table 2 ranks the top 10 states with the largest number of breweries in Brazil, which is led by Rio Grande do Sul State (Marcusso and Müller, 2019).

Brewing inputs and the case of Brazil

All this revolution in the Brazilian brewing scenario heats up the agrarian sector in terms of fully supplying the demand for brewing inputs. Therefore, the production of barley and hops

in Brazil has been adapted according to changes in the new market needs (Lopes *et al.*, 2017).

Table 1. Number of Brazilian craft breweries between 2005 and 2018 and their annual growth

Year	Number of Breweries	Annual Growth
2005	46	-
2006	62	34.8%
2007	72	16.1%
2008	82	13.9%
2009	98	19.5%
2010	130	32.7%
2011	159	22.3%
2012	200	25.8%
2013	255	27.5%
2014	318	24.7%
2015	372	17.0%
2016	520	39.8%
2017	679	30.6%
2018	889	30.9%
2005-2018		1,832.6%

(FERREIRA, 2016; MELZ, 2018; MARCUSO; MÜLLER, 2019).

Barley (*Hordeum vulgare, vulgare* L.) was exclusively planted in the Southern Region of Brazil until the year of 1976 (Gupta *et al.*, 2010) because it is a cold climate plant. Based on research carried out by the Brazilian Agricultural Research Company (Embrapa), this plant sets the standards for the desirable winter cultures at the Brazilian savannah region (Amabile *et al.*, 2008). From the industrial point of view, the barley from this region presents clean seeds, without the presence of fungi and pesticides. Besides, it does not need a long (and often inexistent) dormancy period, being able to be malted soon after harvesting. Therefore, it lacks the long periods of storage necessary for the maturation of the grains and, thus, can supply the internal demand of malt, as well as an alternative for diversification of the production chain (Amabile *et al.*, 2008). The results of Embrapa's research revealed that sowing in mid-autumn in the southern hemisphere yielded better production rates. As for the cultivars developed by the Brazilian institute for the Brazilian savannah region, there are BRS 180 (barley of 6 rows) and BRS 195 (barley of two rows) variations (Amabile *et al.*, 2008).

Table 2. Ranking of the ten Brazilian states with the highest number of artisanal breweries

State	Breweries
Rio Grande do Sul	186
São Paulo	165
Minas Gerais	115
Santa Catarina	105
Paraná	93
Rio de Janeiro	62
Goiás	25
Espírito Santo	19
Pernambuco	18
Mato Grosso	13

(MARCUSO; MÜLLER, 2019).

But, what is malt? The most straightforward answer to this question would be: germinated cereal grain that was subjected to the malting process. Germination represents an important stage in the biological development of the plant and is characterized by numerous metabolic processes. The further analysis of germination generates important information for an in-depth understanding of this process in germinative cultures. The most important application of the germination process in food technology is malting (Manners, 1985). Malting is

defined as the controlled germination of cereals, which guarantee certain physical and biochemical changes, stabilized by grain drying. These changes require a three-step process: (I) immersion of the grain in water to ensure moisture between 12 and 40%; (II) germination, which has the purpose of maintaining embryo growth, protein synthesis and limited endosperm rupture; and (III) drying the germinated grains to ensure the stability of the product (Gupta *et al.*, 2010). Malt plays a central role in brewing, especially considering the metabolic changes during malting, mostly linked to enzymes (Bamforth and Barclay, 1993; Narziß and Back, 2012). The control of the malting process conditions (related to temperature, humidity and germination time) are extremely important, as malting greatly influence the degree of degradation that long carbohydrate chains can possibly undergo, as well as the lipid and protein fraction of the grains (Slack and Wainright, 1980; Narziß and Back, 2012). Also related to enzymatic activity, another important aspect for the quality of the brewing process is the rapid hydrolysis of starch into fermentable sugars. This conversion is mediated by enzymes from the malt, such as α -amylases, β -amylase, limit-dextrinase and α -glycosidase (Manners, 1985). The conversion of barley into beer is one of the oldest and most complex examples of enzyme applications (Gupta *et al.*, 2010). Several fermentable sugars are produced by the action of these enzymes, which include maltose, glucose and some dextrans (Slack and Wainright, 1980; Lauro *et al.*, 1993).

Another essential plant material in brewing are hops (*Humulus lupulus*, Linneus). Hops are a climbing plant of the Cannabinacea family probably originated from China. The history of this ingredient was initially associated to its medicinal properties as a sedative and as a gastric activator (Zanoli and Zavatti, 2008). Its cultivation is currently found throughout the temperate region of the planet. The female inflorescences are responsible for incorporating bitterness, aroma and flavor into the beer. Thus, about 98% of world hop production is aimed towards brewing processes (Moir, 2000). The origins of wild hop gathering preceded its cultivation and, according to Wilson (1975), its cultures began in Germany in the ninth century, between 859 and 875 BC. The interest in selecting new varieties grew during the 19th century (Moir, 2000). Adaptations of wild hops to the cultivation of new clonal selections led to the cultivation of the Fuggle and Goldings varieties in England; the Tettmanger and Hallertauer Mittelfruer in Germany; and Saazer in the Czech Republic, produced up to the present day (Faragó *et al.*, 2009). The Hallertau region in Bavaria (Germany) has the largest hop growing area in the world, comprising one-third of the world's cultivated area. Worldwide, around 50,000 hectares are destined for hops (Hoffman, 2007). The hop is cultivated vertically at pillars ranging from 5.0 to 6.0 m of height to facilitate the growth of the branches. It is often applied a 1.20 m spacing between the individual plants and 3.50 m between rows. This arrangement allows about 2,500 plants per hectare (Araújo, 2007). The development of a new species of hop takes about 15 to 18 years, using between 100,000 and 150,000 plants (Hoffman, 2007). In agronomic terms, the modern cultivars exist due to hybridizations that further manipulated aroma and bitterness, besides creating varieties that are more resistant to diseases. This is especially important, since hop is very susceptible to pathogens like virus, bacteria and fungi (Faragó *et al.*, 2009; Gómez-Corona *et al.*, 2016). Moreover, its cultivation aims not only to meet market demand but also to develop new varieties that exhibit better

performance in terms of α -acids and β -acids, taste, storage stability and high yield (Faragó *et al.*, 2009). These bitter acids correspond from 5 to 20% of the flower dry-mass and are responsible for giving rise to the aroma, flavor and bitterness of beer. The acids composition varies depending on the hops as well as the culture conditions (Vezele and Keuleire, 2013). According to Lafontaine and Shellhammer (2019), hop beers, such as India Pale Ale (IPA) have influenced how much hops are produced and consumed worldwide over the past 10 years, especially in USA.

Brazil imports about four thousand tons of hops per year, surpassing R\$ 200 million (US\$ 61 million). In order to reduce these costs, several attempts have been made to produce varieties of European hops in several places in Brazil. However, they did not succeed until a very unlikely event at the Mantiqueira Mountains changed the course of hop cultivation in Brazil (Araújo, 2016). A frustrated experiment in the Mantiqueira Mountains range became the hallmark of hops cultivation in Brazil. Various plants grown in greenhouses did not support the abrupt changes to the natural environment in the city of São Bento do Sapucaí, due to an increase in rainfall and diseases. Thus, the “dead” plants were subsequently used for composting. A hop seedling was unexpectedly found at that place, showing resistance to the climate, as well as producing valuable feminine flower blooms. This discovery made the cloning of the plant for the development of a hop field possible, which is now destined for organic beer production. The blooming of this variety occurred in early-autumn, as it is harvested manually by cutting the entire plant. This discovery was extremely important for the Brazilian production of craft beer, after all, there is an exclusively national variety that may attain interesting new flavors and aromas to brewing such as freshness, artisanality and regionality. The proximity to beer production sites also allows the use of fresh flowers in the brewing process. In addition to all these characteristics, the use of Brazilian hops allows the incorporation of exclusive elements into Brazilian artisanal beer, as well as the reduction of import-related costs, which may also benefit small rural producers (Araújo, 2016).

Beer-society relationship in Brazil

Mainstream Brazilian breweries have traditionally specialized in the American Adjunct Lager style, which is nationwide referred as Pilsen. Still, the fabrication process itself is not very different from the lagers in the USA (Tremblay and Tremblay, 2012). The combination of reduced costs, universal appeal, and targeted marketing strategies have caused the American Adjunct Lager to achieve enormous sales in Brazil. In recent years, home-brewed beers have been discovered by the Brazilians, thus sparking the desire for experimentation, innovation and creativity in a somewhat homogenous and bland market. Craft beer was able to transform the monochromatic beer scenario in Brazil, once based on standardized marketing and slogans, into something bigger and more complex to the consumers. New microbreweries and brewpubs have tried to differentiate themselves from the homogeneous ‘leading brands’ supply by brewing their own regional product lines and offering diversity never seen in the country. Although the microbrewing scale of production is much smaller, the term “microbreweries” and “homebrew” have become increasingly familiar to consumers across Brazil. Today, this industry has matured and the term “artisanal brewery” has emerged with a positive acceptance bias towards

smaller and independent companies, thus balancing the negative bias of macroeconomic industrial practices. Similar to the American market (Gómez-Corona *et al.*, 2016), there is a tendency of the new Brazilian brands to emphasize quality, flavor and diversity but also restricting beer production to limited amounts. In this context, recently the Brazilian Government had established the Decree n° 9.902 of 08/07/2019 from MAPA (Brasil, 2019) that alters the Decree n° 6.871/2009 and eases beer production in the country. This regulation updates rules for standardization, classification, registration, inspection, production and enforcement of beverages in the country and allows producers to add animal, plant and other ingredients to beer, which could be used to create new recipes, increasing diversity.

A major part of this growing demand for craft beer worldwide is driven by younger generations, born after 1990 (Fromm, 2017). The real reason for this is still widely discussed as a social and marketing phenomenon. Whereas this article does not conclusively present the causes, we stay between conclusive and speculative factors based on the Brazilian scenario. There is an entire new generation of beer drinkers in Brazil that share similarities to other countries as “self-expressive, liberal, confident, and open-minded”. The comparisons established in this section will be guided by this similarity. Especially because such younger demographics is very representative of the population in Brazil, with comprises approximately 75 million young adults (IBGE, 2017). With the huge market potential from these individuals, it has been observed that this age-group prefers to buy products from companies that support solutions to specific social issues. This same generation exhibits a behavior pattern against excessive power and influence in the hands of a few large corporations (Carter, 2017). According to the president of the new Beer Council, founded by Brazilian Ministry of Agriculture, Carlo Lapolli, in an interview with the G1 (Back, 2017), these new brands are so appealing that the public is willing to pay even more for craft beer that is sold at a significantly higher price than the traditional mass-produced beers. Also, according to Koch and Sauerbronn (2019), the motto “Drink less, drink better” (*Beba menos, beba melhor*, in Portuguese) creates and stimulates a subculture of craft beer consumers that reject mass-produced beer. Instead of overconsumption, this public is interested in understanding all the complexity related to artisanal beers, as a rich product developed by devoted brewers.

The complexity of the psychological profile and motivations are beyond the scope of this article; however, we propose that the new generations are attracted to products that reflect their intended lifestyle and personality. In other words, they tend to be adventurous consumers who appreciate the diversity and authenticity brought about by microbreweries. The act of choosing their own specific favorite brands of beer are associated with individualism and loyalty. By choosing which products to buy, new generations are being more influenced by the recommendations of friends (or online comments) than they were through traditional marketing campaigns. This is consistent with the research conducted by Granese (Adventure, 2012) on the American market, which suggested that the decision to consume a special beer is influenced by their social groups. This same pattern occurs in Brazil, where new brands are present in social networks (e.g.: Instagram, Facebook and Twitter), increasing the susceptibility of word-of-mouth influence rather than conventional advertising. Unfortunately,

there is a shortage of national data on the pattern of consumption of new beer brands, but we can safely extrapolate that the expansion of microbreweries is accompanied by a change in the consumption habits. Therefore, the public is strongly interested in knowing a handful amount of new beer brands. Considering the rapid growth of the industry and the emphasis on smaller production and smaller-scale distribution, artisanal beers are inherently “more local” and “less globalized” than large manufacturers that control many worldwide brands (Chew, 2015). Artisan breweries sell their beer based on values such as creativity, tradition and locality that initially serves as a way to create a niche, often based on their communities or specific target audiences. These values combine in several ways to lead consumers to conclude that such brewery is “authentic”. We define authenticity as something unique and detached from the ordinary, which is apparently an important concept for the target-audience of microbreweries.

Craft beer have become increasingly symbols for the revitalization of their hometown as well. Weiler (2000) observed a trend in the US that has been observed in Brazil as well: Brazilian brands such as Eisenbahn (from Blumenau), Colorado (from Ribeirão Preto) and Dama Bier (from Piracicaba) are strongly associated with their place of origin. This is even more explicit in Amazon Beer, a brewery that produces about 70 hL per month, whose brand name was associated with the Amazon rainforest. However, authenticity is a nebulous concept that requires more than that for consumers to label something authentic, as exhaustively discussed by Kovács, Carroll and Lehman (2014), about the second American boom of microbreweries. In essence, authenticity is factual (usually linked to historical facts), but a brewery located in the interior of São Paulo, the coast of Rio Grande do Sul or in the Amazonian forest is not. A beer can be called “Amazon Beer”, but that is not enough to promote its authenticity. It is not enough to be located in the Amazonian rainforest to incorporate the forest or whatever related idea. Examples of success were discussed by Asheville's director of economic development (Frazier *et al.*, 2009), about very two successful American microbreweries: the Sierra Nevada Brewing Co. and New Belgium Brewing. He stated that there are five important considerations in assisting the growth of microbreweries: bureaucratic support, talent and tradition, recruitment, capacity to establish a productive chain and local differentials. He also explained that the city has created a beer-focused certification program at nearby community colleges and universities. While it is believed that a unique solution to attract craft breweries does not exist, understanding the passion and the needs of craft manufacturers for would certainly help guide the process. It is important that, in this context, local governments create intentional growth initiatives to improve the artisanal beer industries in their cities, following the models of the municipal legislation of Blumenau (Gonçalves, 2017) and Santos (Apolinário, 2016). The degree to which the artisanal beer industry thrives and grows is proportional to the interest in policymaking, economic development, and related technical and university training.

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