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MANUFACTURING A CITY IN THE TROPICS: THE BUILDING MATERIAL INDUSTRY IN XALAPA, MEXICO

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ABSTRACT

High rates of urban population growth in Mexico and other tropical (i.e., 'developing') nations create large demands for building materials and construction labor. Using a case study, this article analyzes the development of the building material industry in the Xalapa-Perote region of central Veracruz, Mexico. First, it examines the dominant types of materials used and where these are extracted and/or produced. Drawing on traditional location theory, it then explores why clustering occurred among one of the most popular building material producers, concrete block manufacturers. In the final section, the case study demonstrates that the industry's clustering created a level of competition that not only resulted in the production of poorer quality blocks, but may eventually lessen the job creating capacity of the industry as a whole. This has implications for rural communities, who view access to this local source of employment as its greatest benefit. The research and its findings also have implications for development and industrial geography research in tropical regions, where the combination of traditional location theory and newer locational approaches can be useful for explaining location behavior.

Key words: Cluster competition, construction material industry, labor, location theory, Mexico

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INTRODUCTION

Much of the social and environmental research on tropical countries focuses on the outcomes of expanding cities and rapidly growing urban populations. Understanding the impacts of urban sprawl on land cover, biodiversity, and watersheds, for example, are important areas of concern (e.g., Weng 2001; Pauchard et al. 2006; Li et al. 2007; Grimm et al. 2008). However, there are concomitant social and economic outcomes associated with urban expansion that also warrant attention, including employment opportunities in construction (Ball and Connolly 1987; Firman 1991; Scott and Storper 2003). A key component of capitalist economic development (Hillebrandt 1974; Harvey 1978; Ball and Connolly 1987; Giang and Pheng 2011), the construction sector plays a particularly important role in the economies of urbanizing areas of the tropics where housing demands are growing at unprecedented rates (UNFPA 2007). For development and government decision makers, therefore, understanding where and how components of the construction sector affect regional economies are integral to development initiatives in tropical regions (Scott and Storper 2003). This article uses a case study to examine the role that location, clustering, competition, and labor play in the development of the building material industry in and around Xalapa, the capital city of Veracruz, Mexico.

THE URBAN PROCESS AND BUILDING MATERIALS

As Harvey (1978 p. 113) notes, "[t]he urban process implies the creation of a material physical infrastructure for production, circulation, exchange and consumption." A first step in creating urban infrastructure is the identification of suitable building materials. Indeed, the availability of construction materials is central to the establishment of cities as well as their continued expansion. Typically, regional natural resources, including geologic and forest resources, determine which building materials are utilized. For example, ancient Athens was built from readily available raw materials, and although mud bricks predominated, marble and limestone were also quarried from surrounding hills (Wycherley 1974). As cities grow, the scale of construction material extraction increases. Exhausted mines are abandoned and often enveloped by urban growth (Connolly 1982; Colten 1994). New materials are sought, additional mines and quarries exploited, and more natural resources are converted into the urban physical infrastructure. Although the local biophysical environment provides the raw materials, other factors affect the specific localization of mines and building material production facilities.

The location of construction material mines is also influenced by tensions between accessibility and land rent, as well as competing land uses. First, transport costs comprise a large component of the total production costs of construction materials due to their bulk (Wallwork 1974). For this reason, proximity to roads or other forms of transportation often determine the location of material mines. Second, land values tend to decrease with increasing distance from the urban core (Alonso 1964), and the combination of high urban land rents and low value building materials serve to push material mining far from city centers. Third, as urban areas expand, home owners increasingly vie for land in urban peripheries; in time, concerns about environmental impacts and conflicts over aesthetics can force mine closures and the relocation of mining activities to areas even farther from population centers (Campbell and Roberts 2003).

The production of materials such as bricks and concrete blocks also require secondary processing industries. The locations of these industries, sometimes close to source areas and other times nearer to urban markets, may depend on the availability of labor. To Walker and Storper (1981 p. 497), the profitability of an area for industrial location not only depends on the availability of natural resources, proximity to final markets, and/or agglomerative forces, but also ultimately involves the labor supply. For location decisions involving building material manufacturers in the United States, Canada, Japan, Australia, and European countries the importance of labor may be of marginal importance because the manufacturing process is overwhelmingly mechanized. Conversely, in places where mechanization is absent and/or labor costs low, as in tropical (i.e., 'developing') countries, the labor factor is likely to play a more important role in locational decisions. In Mexico, one of the most popular building materials is concrete blocks (INEGI 2011; Fry 2008). However, little is known about the relationship between the production of concrete blocks, labor, and the industry's development.

CONCRETE BLOCKS AND MEXICO'S CONSTRUCTION SECTOR

Since the 1970s, Mexico's urban population has grown from ~28 to ~79 million, and from approximately 60 percent to 76 percent of the country's total population (INEGI 2011). Urban building and construction accompanied this population growth, as evidenced by the fivefold increase in the volume of concrete aggregates extracted from 1970 to 2003 (González-Martínez and Schandl 2008). Home construction accounts for a large share of Mexico's urban construction (Ball and Connolly 1987). Since the 1970s, informal, self-built homes comprise over 50 percent of homes built in Mexican cities (Connolly 1982; Schteingart and Solís 1994). For low-income residents who build their own homes, pre-fabricated concrete blocks are highly desirable due to their low cost, durability, and ease of use (Fry 2008).

On average, concrete is 80% aggregates, 12% Portland cement, and 8% water. Portland cement chemically reacts with water to bond the aggregates. Aggregates are either natural (e.g., sand, gravel, pumice) or manufactured (e.g., crushed stone, coal cinders, slag). To manufacture concrete blocks, concrete mix is poured into a mold, compressed by either hand or machine, and left to harden or cure. In some places, crude blocks are made by hand tamping concrete mix in molds. Vibrating machines allow for the standardization of block size as well as for their mass production. Producing blocks is but one component of the larger construction sector.

For Mexico, as well as other capitalist-oriented tropical countries, home construction, whether formal or informal, is and will continue to be an integral component of regional economic development, especially when access to other types of industries remains limited (Connolly 1982). Since the construction sector is recognized as a region-serving transaction that recirculates money through the regional economy, states sometimes directly intervene to promote growth in the sector (Harvey 1978). For example, Mexico's government deregulated the housing market in the late-1990s and began to finance the purchase of properties, as well as home construction and renovation. Harner et al. (2009) argue that this not only spurred construction, but also fueled widespread speculation and unfettered urban expansion in Guadalajara. Even without direct state intervention, non-export-oriented regional economic development is fueled by the demand for informal homes created by large numbers of low-income rural migrants flooding into tropical cities (e.g. Padoch et al. 2008; Firman 1991). Isolating components of the construction sector, especially the informal sector, which often falls outside of standard economic analyses, is one way to shed light on how, where, and why individual industries develop, as well as how they affect regional economies.

STUDY AREA AND RESEARCH QUESTIONS

Since the 1980s, medium-sized cities (i.e., population of 50,000 to 500,000) have experienced the largest percentage of Mexico's urban population growth (Aguilar et al. 1996). For example, in Xalapa, the capital city of Veracruz, the population more than doubled to over 500,000 between 1980 and 2000; while its surficial area increased sixfold in the same time period (Capitanachi Moreno et al. 2003). Accompanying Xalapa's growth was an increased demand for construction materials; particularly, inexpensive lightweight concrete blocks made from regionally mined volcanic pumice known as *tepetzil*. Tepetzil concrete block buildings not only affected the structural aesthetics of Xalapa's built environment (Fry 2008), but the extraction of tepetzil impacted rural environments and households in the Perote Valley where it was mined. The block industry also provided an important source of employment in the region. This article examines the relationship between the regional building material industry in Xalapa, and block production and labor in Perote. Three questions guide this analysis: 1) How does the production of tepetzil blocks compare to other building materials used in the region around Xalapa? 2) How and why did the tepetzil block industry develop in the Perote Valley? 3) What is the relationship between labor and the block industry?

METHODS

Field research was carried out during several visits to the Xalapa region between 2004 and 2009, with the bulk of the data gathered during a long field season from June 2005 to December 2006. Both formal and informal interviews were carried out over the course of the study. Beginning in 2004, preliminary information on the types of construction materials, the location of material sources, and the level of community involvement was gathered through participant observation (e.g. accompanying truck drivers on deliveries) and informal interviews carried out with mine owners, workers, and truck drivers in and around Xalapa. In addition, the locations of material mines and tree plantations were mapped using a GPS in 2005, 2006, and 2009.

To determine supply and demand of building materials, formal interviews were carried out with 39 building material shop owners and workers in neighborhoods throughout Xalapa. In

December 2005, material shops were chosen using a stratified random sampling method based on neighborhood growth rates. Specifically, 134 neighborhoods were grouped into six categories according to growth rates and then seven neighborhoods were randomly selected from each category. A total of 40 material shops agreed to participate in interviews. Using structured questionnaires, interviews asked about the types, amounts, prices, and sources of materials being used/demanded and historical and contemporary building trends in Xalapa. As well, some respondents with decades of experience in Xalapa's building industry agreed to longer, open-ended interviews that provided information on historical developments.

In 2005-2006, informal and opportunistic group interviews were conducted at 78 block manufacturing operations in Sierra de Agua in the Perote Valley. Sierra de Agua is an *ejido* community where tepetzil is mined and blocks are manufactured.[1] Block workers and owners were asked about their clients, production capacity, input costs, and number of years in operation. Laborers were also asked where they lived.

Many of the laborers working in Sierra de Agua came from the ejido communities Veinte de Noviembre and El Conejo. In 2006, a total of 190 ejidatario and non-ejidatario households (i.e. land-owning and landless households, respectively) were selected from the three ejido communities (in 2006, total populations were 1384 in Sierra de Agua, 465 in Veinte de Noviembre, and 1205 in El Conejo). Using a stratified random sampling method, 190 households were selected for interviews. Survey data were gathered from 167 of these households, 23 households either refused participation or were unavailable. The survey was designed to identify livelihood strategies, income sources, and other information. Informal discussions with household heads and other family members usually followed the survey. Semi-structured interviews were also conducted with municipal representatives, ejido members, block manufacturing operation owners, block workers, drivers of front-end loaders, and block machine repairmen in the Perote area.

RESULTS AND DISCUSSION

Regional Building Materials

The various types of materials observed in buildings throughout the city, in addition to numerous defunct mines and newly opened mines, testify to the dynamic nature of construction material mining and use in and around Xalapa. For example, the diverse geology of the eastern portion of the Trans Mexican Volcanic Belt, where Xalapa is located, enables the exploitation and use of a wide array of construction materials, including: limestone, volcanic basalt, volcanic pumice (i.e., tepetzil), volcanic cinders, quarried ignimbrite, pyroclastic sand, and clay deposits. As well, some timber is extracted from pine forests and plantations on upper slopes of the Cofre de Perote (Figure 1a and 1b).

Since the early 1990s, construction material shops, most abundant in those areas with the highest growth rates, provided the most commonly used construction materials to consumers in Xalapa, and thus played an important role in shaping home construction.[2] In 2005, material shop owners reported the volume of material sales in order of importance as 1) cement, 2) lime, 3) rebar,

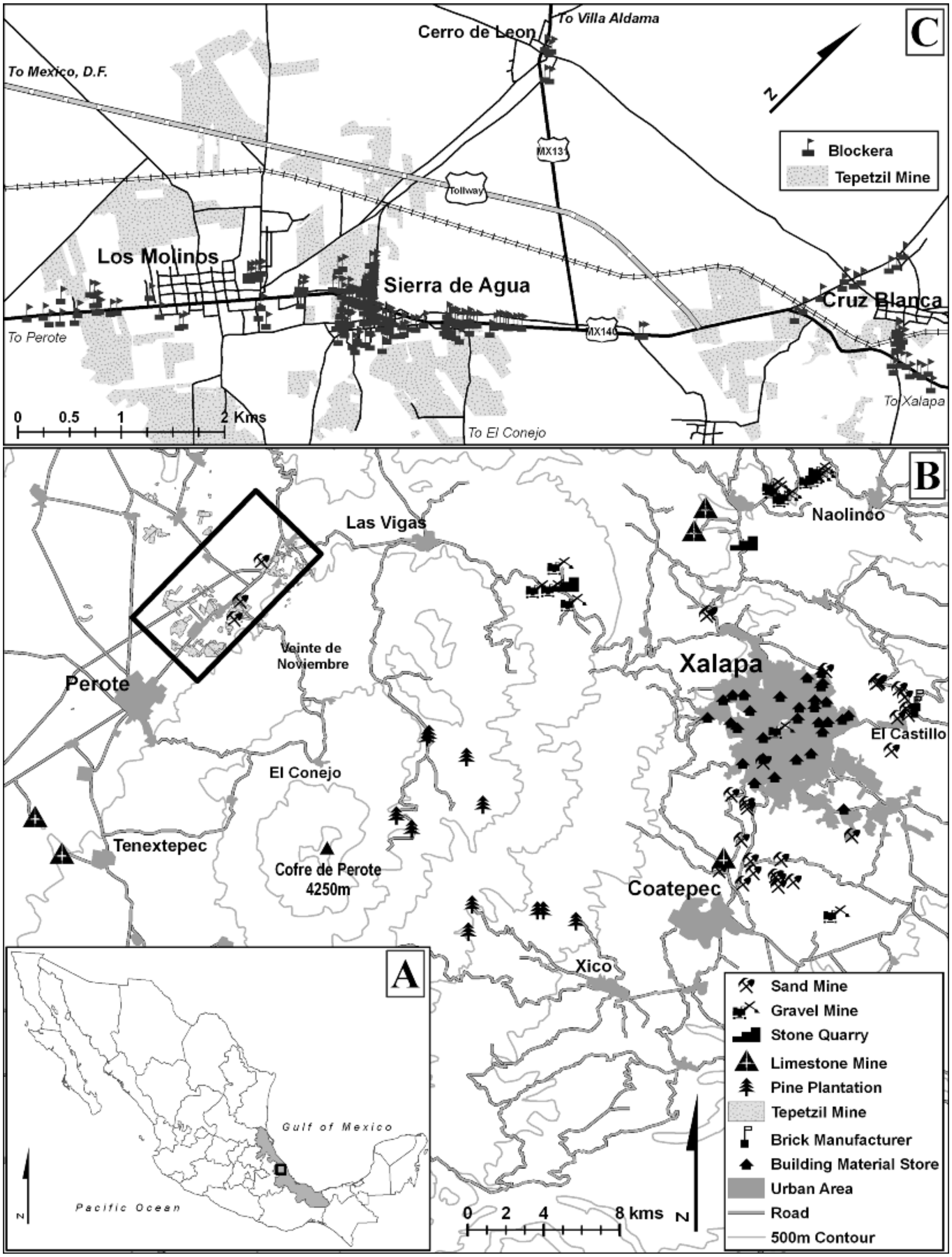


Figure 1. The Central Veracruz Study Area

4) sand, 5) tepetzil blocks, and 6) volcanic cinder gravel. With the exception of cement and rebar, all construction materials were regionally mined. In addition to over 100 tepetzil mines, the 52 active and inactive material mines mapped include 30 sand mines, 14 gravel mines, 3 stone quarries, and 5 limestone mines (Figure 1b).

Construction aggregates are high tonnage, low value commodities. To reduce overall production costs, suppliers attempt to minimize expenditures on extraction and transportation (Wallwork 1974). For this reason, the location of construction material mines in and around Xalapa depends on the ease of access to geologic deposits. For example, mine types tend to cluster in areas with large, exploitable deposits that are easily accessed from roads. Indeed, most mines were located adjacent to or within ~1km of roads (Figure 1b). As well, although obtaining the extraction dates for all mines was not possible, construction material mining appears to have moved farther from the city over time, suggesting the most accessible deposits were targeted first.

Since the late 1980s, tepetzil became one of the most important building materials in the study region. Tepetzil blocks are not only lightweight and therefore inexpensive, but are easy to use, durable, and are ideal for incremental home construction – a common technique used by low income home builders (Fry 2008). For these builders, blocks were preferred to other materials, especially clay and sand-based bricks. In terms of location, both brick and block manufacturers were located closer to their respective raw material sources, rather than in Xalapa. The reasoning for the clustering of the block industry is explored in the next section.

Tepetzil Block Industry

Evolution and Development

Tepetzil is mined from shallow subsurface deposits in the Perote Valley. A strip of communities along the southeastern rim of the Valley is the primary area for tepetzil mining and block processing (Figure 1c). Most of the *blockeras*, or small-scale block processing facilities, lie along the historic highway, MX140. The majority are clustered in Sierra de Agua, close to, or even within, tepetzil mines. Conversely, only one interviewed material shop owner operated a block-making facility in Xalapa close to the main market. Traditional location theory is useful for explaining how and why clustering occurred in the tepetzil industry, while more recent theorizations help to clarify the competitive advantage maintained by the clustering (e.g. Porter 2000). As McCann and Sheppard (2003) argue, observations of location behavior are best resolved through the combination of traditional microeconomic location theory and newer locational approaches. Accordingly, this section examines the tepetzil industry in the context of classic location theory, while later sections examine the industry in terms of competition.

Although Weber's (1929) location theory predicts that heavy industries with high transportation costs tend to cluster together, Wood (1969) suggests that agglomeration of these industries implies something more. For example, to Pred (1965) the concentration of value-added industries results from self-perpetuating momentum, accumulation of skills, and the standardization of production processes, among other things. Indeed, in addition to locating near the raw material source, the clustering of the block industry appears to have resulted from self-perpetuating momentum and the standardization of production.

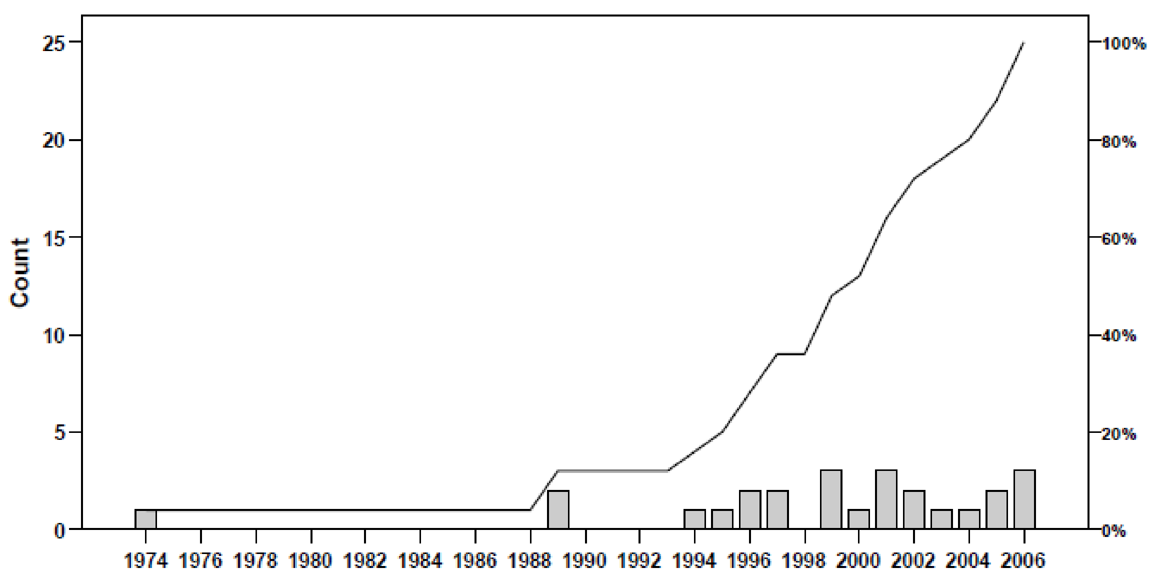
The momentum and production standardization of the block industry in Sierra de Agua occurred over time. The first tepetzil blocks were fashioned in the 1960s for local use. At the time, everything was manual: tepetzil was shoveled onto wagons or wheel-barrows, shovels and buckets of water were used to mix the tepetzil and lime mixture, which was tamped into molds using wood or metal pallets, and, finally, the forms were flipped by hand. In the 1980s, increased demand sparked the opening of more blockeras. More men, particularly non-ejidatarios from Sierra de Agua, began to make blocks. Portland cement also replaced lime in the concrete mix at this time. Around 1986, the first vibrating machine arrived in Sierra de Agua, shortly thereafter, the first front-end loaders arrived; mechanization made mass production and large-scale extraction possible.

Although the first boom in tepetzil block production was in the 1980s, the renaissance for Sierra de Agua's block industry came in the 1990s when improvements in productivity enhanced the overall prosperity of the industry (see e.g., Porter 2000). By 2000, demand for tepetzil blocks had spread well beyond the region and today blocks can be found as far north as Nueva Laredo on the United States/Texas Border, as far south and east as Cancún in the Yucatan Peninsula, and throughout large urban areas such as Puebla and Mexico City. More demand, more extraction, more tepetzil, and more vibrating machines led to the need for more laborers (see Table 1). In fact, laborers were in no short supply due to dramatic declines in agricultural prices and government subsidies for smallholder agriculture, which occurred in the late 1980s and early 1990s and caused many agricultural laborers throughout Mexico to seek non-farm employment (de Janvry and Sadoulet 2001; Hamilton et al. 2003; Perramond 2008). To one informant, it was around this time that the block industry fundamentally changed: "the quality [of blocks] changed, the work changed, the people changed, the hours…Neighbors moved in and sold [blocks] cheaper than we did…It was very different than before." Today, all tepetzil blocks are produced using manually operated vibrating block machines.

In 2006, around 350 block manufacturing operations employing approximately 1400 workers (i.e., 4 workers per block manufacturer) were located in the Perote Valley. Most block making facilities were two-stories (*blockera sobre desnivel*), many of which opened after 1995 (see Figure 2). In the more successful blockeras, dump trucks hauling 5 to 12 m^3 of tepetzil arrived on a daily basis. The tepetzil was dumped onto the second story and funneled downward into a mixer (Figure 3). After mixing, the mix was released onto the ground and gradually shoveled into the block machine. Two machine operators filled the vibrating machine with mix and dropped the compression lever. The runner pulled two blocks at a time from the machine, loaded them onto a cart, and stacked the blocks in rows for curing. After a day of curing, blocks were re-stacked individually by the stacker to make them ready for loading onto flatbed trucks.

Table 1. Estimated Rates of Tepetzil Block Production in the Perote Region of Central Veracruz

YEAR	Block Laborers	Blocks per worker per day	Blocks produced per year	Most common block dimensions (cm)	Blocks per 50kg of cement
1976	30	128	1,113,600	50x20x40	42
1986	150	232	10,092,000	12x20x40 14x20x50	62 55
1996	600	532	92,568,000	12x20x40	76
2006	1400	608	246,848,000	12x20x40	77.5



Bars represent the opening of individual blockeras, while the line represents the cumulative count.

Figure 2. Opening Years for a Sample of 25 Blockeras in Sierra de Agua.

Source: the author

Figure 3. A Two-Story Block Production Facility (*Blockera Sobre Desnivel*).

Tepetzil aggregate is funneled to a mixer and shoveled by hand into the vibrating block machine. A team of block loaders can be seen in the background to the right.

Owners, Financing, and Input Costs

According to data collected from 167 household interviews, blockera owners were ejidatario and non-ejidatario residents of Sierra de Agua. In 2006, owners were of two types: those that not only owned but worked in one or two blockeras (i.e., small-scale owners), and those that owned, but did not work in, 3 or more blockeras (i.e., large-scale owners). The majority of the large-scale owners were non-ejidatarios who started making blocks in the 1980s and early 1990s. With the introduction of block machines, many in this group found themselves in a position to capitalize on a growing network of clients demanding blocks, as they had both facilities and capital. They eventually became the principal financial beneficiaries of the

young or old, the capital investment required to establish a blockera was often shared among family members, typically between brothers. As Biles (2004) found for households in southeastern Mexico, few of the block owners sought loans from formal institutions and instead relied on the informal sector. For example, money for purchasing a block machine was often obtained through familial loans. In some cases, land-owning parents sold the tepetzil from below their agricultural fields in order to fund a son's blockera. Otherwise, as in one instance, a respondent sold a sheep herd to buy a block machine, while another worked in the United States for five years and used the money to buy a block machine and a dump truck.

In addition to vibrating block machines, input costs for blockera owners included land, building infrastructure, tepetzil, Portland cement, labor, and monthly water and electricity fees. In September 2006, $6m^3$ of tepetzil sold for 90 pesos (US$8.50) and the cheapest cement cost 80 pesos (US$7.55) per 50 kg bag. Excluding the fees for water and electricity, the estimated costs associated with the production of 1,000 blocks in 2006 were: tepetzil = 469 pesos (US$44.25), cement = 1000 pesos (US$94.34), and labor (average) = 21.5 pesos (US$2.03). Wood (1969, p. 35) notes that the clustering of manufacturers can result from the need to maintain speed and frequency of contacts with consumers and suppliers, which may explain the concentration of blockeras along MX140. In turn, the proximity of blockeras, customers, suppliers, and other institutions likely served to amplify competition as well as productivity within the industry (Porter 2000).

Clusters and Competition

To Porter (2000), competition among clustered firms allows clusters to maintain a competitive advantage. For block manufactures in Perote, this was reflected by a sort of 'brand loyalty' that was associated with blocks produced in or around Sierra de Agua. For example, during interviews in Xalapa, it was often stated that the best blocks were made in Sierra de Agua. According to Callarisa Fiol et al. (2009) customers' perceptions of the higher value of goods produced within a cluster can act as barriers to producers located outside the cluster.

For non-clustered producers, the only way to compete on equal terms would be to establish a base within the cluster (Callarisa Fiol et al. 2009 p. 306). Once embedded within the cluster, competition not only enhances productivity and innovation (Porter 2000), but also drives ineffectual producers out of business.

Although competition may have lead to their industry's competitive advantage over producers outside of Sierra de Agua, it was of little consolation to small-scale blockera owners who consistently complained that competition was one of the biggest hurdles to their prosperity. Many struggled to compete for clients, pay for increasingly expensive electricity, and afford higher priced cement. In order to decrease total costs, some owners paid lower wages, while others cut back on the amount of cement used to make blocks. Unfortunately, cutting back on cement diminishes the structural integrity of blocks (Fry 2009). Therefore, this strategy seems likely to backfire because low quality blocks probably discourage customers from returning. Not to mention that the use of inferior blocks by home owners will likely have long-term repercussions and present serious safety hazards in a region prone to earthquakes!

Porter (2000) also argues that competition eventually leads to a shift away from cost cutting to innovation and differentiation. While some block producers did innovate, the differences between cost-cutting strategies and innovation and differentiation were not always obvious. For example, some blockeras were built on the sides of tepetzil pits, which could be interpreted as a way to reduce input costs because it used less building materials on land acquired relatively inexpensively; but it also added a third story, an innovation in the production process that allowed gravity to replace one of the laborers (and cut costs) normally required for shoveling concrete mix. Conversely, changes in block dimensions suggest the development of innovative strategies over time – or what Pred (1965) refers to as the standardization of production processes (see e.g., Table 1). Likewise, in 2007, one blockera owner was experimenting with steam curing, an innovation that reduces the water retention capacity of finished blocks. However, it remains to be seen how cost cutting and innovations will affect the number of laborers working in the block industry. This is important because the industry's primary economic and social benefit is its use of a large labor force.

Labor and the Block Industry

The conversion of raw materials into more valuable commodities occurs at any number of stages. For construction materials in central Veracruz, the number of value-added steps depends on the type and nature of the building material (Figure 4). For example, sand is first mined and then transported (often by material stores) to construction sites. The manufacturing of tepetzil blocks requires two additional stages, one more for transport and one for manufacturing. Moreover, and as Figure 4 demonstrates, the amount of labor varies at each stage. Construction work at the job site and building material manufacturing are both labor intensive.

In 2006, Sierra de Agua's block industry showed a clear pattern of labor-market segmentation (i.e., differences in the types of labor, working conditions, and level of commitment; see e.g. Firman 1991). The industry was comprised of blockera owners, block makers, block stackers, and block loaders. Wages in the block industry varied according to type of work (i.e., block maker, stacker, loader), the generosity of the owner, the consistency of the customer base, the efficiency of the work team, and the community of origin. Within the block industry, residents of Sierra de Agua participated in all of the various block related jobs and the majority of block owners were non-ejidatarios with incomes in the top third of all households. Among the three surveyed ejidos, the majority of block makers were non-ejidatario (i.e. landless) household members from Veinte de Noviembre and El Conejo.

The household interviews show that blockera owners earned the most money and block stackers earned the least (Table 2). Annual incomes for block making ranged from $1,000 to $5,200, though many people did not make blocks throughout the year and only worked when their household needed money. Moreover, differences in piece wages are common in Mexico's small-scale construction material industries (e.g. Cook 1984). In Sierra de Agua in 2006, a good team of block makers earned up to 1500 pesos/week ($142) each, while a good team of block loaders made as much as 3500 pesos/week ($330) each. Conversely, pay was as low as 450 pesos/week ($42) for block making and 600 pesos/week ($57) for each member of a less competitive loading team.

In 2006, blockeras were the main regional source of employment for unskilled laborers. Most block makers were "*chavos*" (young men) from Sierra de Agua and other communities in the region. Like agriculture, work in construction has few barriers to entry (Ball and Connolly 1987); this is true for making blocks as well. According to most informants, older residents and ejidatarios remained in their communities and farmed, whereas

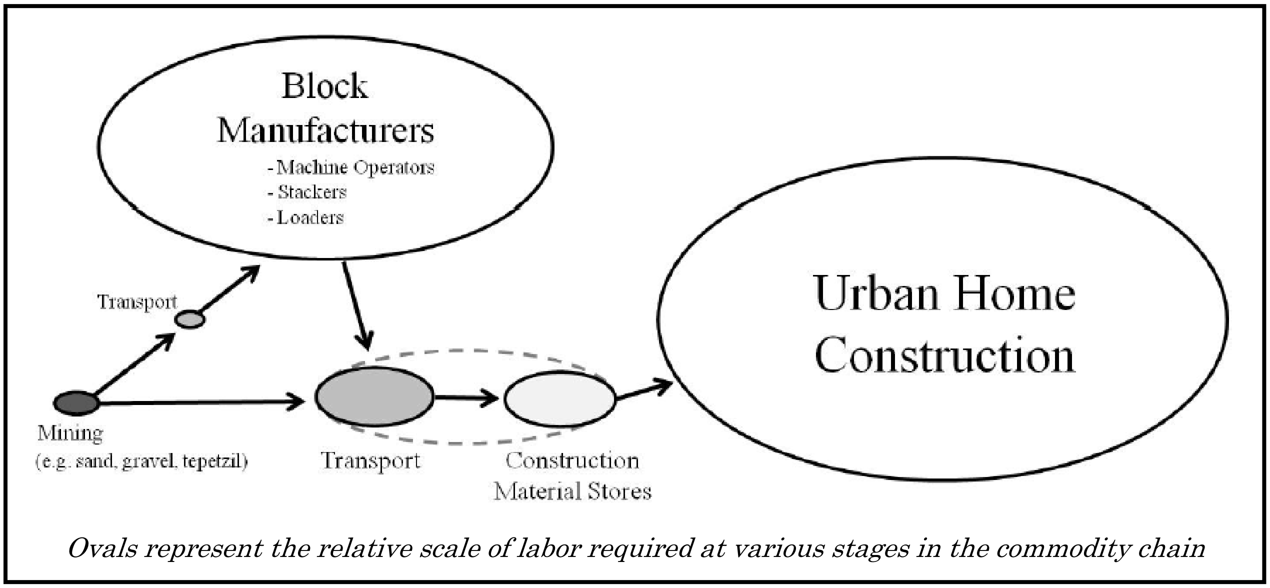


Figure 4. Central Veracruz's Construction Material Commodity Chain

Table 2: Estimated Annual Earnings for Selected Income Sources in Perote Region, 2006

Primary Income Source	Annual Earnings ($US)
Own blockero	$4,000 - $12,000
Make blocks	$1,000 - $5,200
Stack blocks to dry	$1,000 - $4,100
Load blocks onto trucks	up to $5,000
Agricultural wage labor	$700 - $2,200

Source: *household interviews*

low-skilled laborers from other regions could have entered into the industry, although their access to certain types of jobs (e.g., block loading) as well as higher paying jobs would have been restricted. For example, residents from El Conejo were consistently paid less per day for making blocks than residents from either Sierra de Agua or Veinte de Noviembre. The greater distance between El Conejo and Sierra de Agua (e.g. 30min bus ride, compared to 10min bus ride from Viente de Noviembre) may partially explain this discrepancy. In addition to this spatial distance, the community also entered into the industry later. For example, 65 percent of El Conejo household members who worked in Sierra de Agua's block industry entered after 2000, compared to 19 percent in Veinte de Noviembre and 23 percent in Sierra de Agua. In sum, although the labor factor was not instrumental to the localization of the block industry in Sierra de Agua, the industry's location in Sierra de Agua affected both the type of labor and amount of pay available to laborers.

From a development or applied perspective, the most important aspect of Sierra de Agua's block industry, as local residents overwhelmingly agreed, was that the industry's presence was beneficial to local communities. Interestingly, it was not only the economic advantages, but also the social advantages that residents most appreciated. Regardless of variations in pay and working conditions, households in the study area principally benefited from their proximity and access to block industry jobs. The following quote was typical, "[b]efore, people left to work in other places, but with the tepetzil resource we can stay here and look for work here". In particular, young men and non-land owners did not have to migrate to cities, agriculture regions in northern Mexico, or the United States in order to maintain their household's livelihood – as was the case for many rural Mexicans during the late 1990s and early 2000s (see e.g. Wiggins et al 2002; Cornelius 1998). Veinte de Noviembre household members were particularly cognizant of this fact. Due to the accessibility of jobs in neighboring Sierra de Agua, households stayed together, lived full-time in their home community, and remained close to family and neighbor support networks. By creating jobs, building material manufacturing, like other types of rural small-scale industries, not only serve to generate incomes and regional economic growth (Fisher et al. 1997), but these industries offer social benefits as well. As farming wanes, these types of industries are likely to become the main source of employment and income for rural landless households. Understanding where and how building material manufacturing affects rural labor markets, therefore, is integral to development initiatives in tropical countries, where the demand for construction materials will continue to grow.

CONCLUSION

The importance of construction material manufacturing in tropical nations can be summarized by two United Nation's studies. In the 1970s, the United Nations Industrial Development Organization referred to small-scale industries as "a major development objective" that could "provide adequate employment opportunities and fulfillment of basic socio-economic needs of poorer communities, mostly resident in rural areas" (UNIDO 1980 p. 5). In 2007, the United Nations Population Fund (UNFPA) found that tropical countries are experiencing, and will continue to experience, the highest rates of urban population growth. To Scott and Storper (2003 p. 580) “the theory of development must incorporate the role of cities and regions as active and causal elements in the economic growth process.” The manufacturing of building materials represents one example of the development and economic potential of urbanization.

As this case study demonstrates, the location of construction material mines and the clustering of construction material manufacturers are primarily based on local geology and accessibility. Although the availability of labor was not crucial to the block industry’s location in Sierra de Agua, it did provide economic and social benefits to many residents. The development of the industry over time demonstrates how and why clustering occurred. Gaining a competitive advantage over producers in other areas was one outcome of the industry’s clustering. However, this came at the expense of increased competition between the local block producers. In turn, cost cutting and innovative strategies could have negative effects, including the production of poorer quality building materials and decreased demand for labor. Indeed, more innovations in the industry, particularly mechanization, could be detrimental to the industry’s job creating capacity, which would remove one of its greatest benefits to communities in the region.

NOTES

1. Ejidos are collective forms of land ownership that came into being as a result of the Mexican Revolution (1910-1921). While no two ejidos are alike, ejido members (ejidatarios) typically own individual parcels of land and often collectively manage communal forests or rangeland. Thus, ejidos are both geographic spaces and social institutions. In 1992, ejido structure underwent significant changes when the federal government amended Article 27 (the Agrarian Law) of Mexico’s constitution. For example, prior to changes to Article 27, neither ejido titles nor land could be sold; instead, title and land were left to one heir. Today, ejidatarios have titles to their land, which they can sell.

2. Though a Home Depot was built in Xalapa in October 2005, this type of store is a relatively new concept in the region. In general, material shops are locally owned and operated.

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