Megacities: Challenges and Opportunities

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Executive Summary

Mass migration to urban centers will not only fuel the physical growth and expansion of cities into new megacities, it will concentrate labor and capital, test the durability and resiliency of logistics lines and resource and energy production, and create new security and social stability challenges.

- Urban migration will likely provide businesses with fresh sources of inexpensive labor and capital, while offering businesses opportunities to service a growing urban-middle class that seeks new occasions to consume previously unavailable goods and services.
- New megacities, (metropolitan areas consisting of populations greater than 10 million), will likely face challenges as production and distribution systems try to meet the demand for energy, food, water, and consumer goods.
- Large urban centers — long considered incubators of social unrest — are likely to see conflict, as disparate populations suddenly find themselves in proximity and competition for potentially scarce resources, or as governments or elites misallocate or misuse limited resources, widening the gap between the wealthy and poor.

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Urban Migration and Growth

Population experts generally agree that as the worlds' population races toward 9 billion people — the commonly held medium-variant population projection for 2050 — *urban areas will see the largest growth*. Considering that currently developing nations are likely to account for the bulk of overall global population growth, cities in Bangladesh, Brazil, China, India, Indonesia, Mexico, Pakistan, and the Philippines are likely to see the greatest expansion. Meanwhile, established megacities, such as New York, Tokyo, Seoul, Mumbai, and Beijing — estimated to see static or even declining populations in the next 20 years — will remain important centers of commerce, governance, and culture because they have the capital, experience, and maturity that new megacities will look toward for guidance and support.

Metropolitan centers are economic engines of prosperity having historically accounted for up to 80 percent of global economic growth. This trend almost certainly will continue and likely accelerate as urban populations become larger. Cities have historically achieved prosperity because they naturally draw labor and capital together. The likely massive injection of cheap unskilled labor from developing countries into cities will almost certainly garner the attention of capital, which is likely to harness these people to build the infrastructure, industry, and service economies of rising megacities. Profits made from this low-cost labor will likely give rise to a new, and larger, middle class of managers, bureaucrats, and white-collar professionals who will have newfound economic means to spend on consumer goods and services, creating a cycle of urban economic growth.

Population size and economic growth alone, however, do not define the trend toward urbanization and will not determine the trajectory of new megacities. **Successful megacities will need to manage and adapt to scarce resources, especially electricity, water, food, and essential nondurable goods.** Metropolises that adopt energy efficient policies, conserve water, promote greenspaces and even urban farming, and maintain transportation and trade lines to provide food and consumer goods to their populations will likely fare well. Meanwhile, cosmopolitan centers that have insufficient power production and transmission lines, limited access to and delivery of food and water, and poor or absent infrastructure to move both goods and people effectively throughout their borders will falter.

Challenges for Megacities

Cities, especially the megacities of 2050, will consume massive amounts of electricity for industrial and residential use. Most estimates suggest developing countries, which are likely to experience the largest urban expansions, will increase their energy demand by approximately 60 percent or more by 2050, but many of these nations lack sufficient electrical production and distribution infrastructure.

In addition to energy, new, large urban areas will need considerable access to food and water. Cities are among the highest consumers of water. Right now, Beijing, Doha, Los Angeles, Delhi, and Tokyo are facing water shortages, and other developing areas in Asia, India, and Africa, are suffering from water scarcity. The United Nations Food and Agriculture Organization estimates that as the global population trends toward 9 billion, global food production will need to increase by 70 percent. However, as cities swell to absorb the influx of new residents, sprawl and urban pollution is likely to consume and threaten

valuable agricultural land, and smaller rural populations, traditionally associated with food production, may not be robust enough to meet the demand for food.

The new large urban centers of 2050 are likely to possess many of the elements that can lead to social unrest. The sudden influx and juxtaposition of rural migrants from disparate areas, ethnicities, and cultures may breed a variety of conflicts that could break along ethno-sectarian divisions, sociopolitical fissures, or economic lines. Adding to the friction, future megacities will be stark examples of wealth gaps, with the affluent and newly minted middle class likely insulating itself from the newly arrived and poor. This segregation usually breeds strife as civil uprisings often have underpinnings in matters of class and economic inequality. Finally, the most significant urban growth is likely to occur in developing countries, which are often characterized by ineffective bureaucracies, political disenfranchisement, meager regulation, poor public service provision, and uneven distribution or absence of effective security and judicial services. This gap means that the government and security services mostly likely to experience significant urban growth are the least able to counter popular discontent, presenting a prime environment for conflict.

Significant challenges will follow as infrastructure must keep abreast of swelling population; most notably health and safety needs. Adequate and safe water, food supply, and sanitation are paramount to sustainable megacity evolution and structure. Current and projected challenges in shortages of water supplies and food security point to the necessity for advanced technologies into conservation, supply and agricultural innovation. Sanitation issues to protect against large-scale disease outbreaks that could not only cause massive healthcare disruptions but business continuity issues, must also be considered.

Feeding Megacities – Agriculture and Livestock

As population expands, economic disparity will grow, as will the unequal access to food, shelter, and energy. Wealthier populations have been shown to consume more proteins, typically in the form of meats. This additional stress on existing land and energy, required for livestock cultivation, coupled with increased population housing demands, cannot be met with the current agricultural methods used today, as well as anticipated climate change and environmental stressors.

By the year 2050, it is predicted that meat demands will be 54 kg (119 lbs.) per person per year based on current consumption. Beef requires 10 kg (22 lbs.) of grain and 15,000 liters (15.6 qts.) of water to produce 1 kg (2.2 lbs.) for market delivery. Additionally, cattle are responsible for approximately 18 percent of all global greenhouse gases, more than all worldwide motor vehicles. Although pork requires less than half the grain and water than cattle, supplemental alternative protein sources to meet future population needs, especially for very large cities and amid extreme weather and increasing animal-to-human disease threats, must be found. Economically viable livestock farming methods force ranchers and growers to crowd animals, making disease threats more hazardous and giving rise to potential emerging pathogens that threaten humans, as well as food sources. Drought, floods, and other hazards also endanger livestock growers.

Reasons for Hope

Finding technological alternatives that are sustainable for the masses will become a priority, and the cultural acceptance of altered diets, such as plant proteins, will be a necessity for healthy sustenance. Research and prototypes have already emerged for printing foods based on elemental proteins and enzymes that can be customized for individual diets and nutritional needs. As technology rapidly advances over the ensuing decades, mass production of inexpensive sources of complex foods may become more reality than science fiction. Factories of hydroponic and aeroponic grow-houses for produce can be built within the cities themselves, as vertical farming factories. Portable and collapsible units are already market available for consumers to have year-round, climate controlled affordable systems in their homes. With the surge in population expected by 2050, the demand for food is expected to rise by 70 percent overall globally. The challenge is not merely in producing 70 percent more food, but in making this food available by decreasing losses through supply chain attrition, poor storage, accident, and theft.

Providing Water to Millions of People

Presently, 84 percent of the population in urban settings globally has access to improved water sources; however, those sources may not be affordable to all or have reliable delivery in some areas. As cities expand, with disparity among wealth "centers" and less affluent areas, this percentage may increase if precautions are not taken. If current agricultural practices prevail, by 2050, water demands for raising crops and livestock will increase by 20 percent. Agriculture draws on over 70 percent of the world's freshwater use. Water used for irrigation and drinking is negatively impacted by natural disasters through contamination, diversion, and reduction from drought, storms and flooding, and often energy production use. Crop demands for water can be tremendous and wasteful when less than optimal techniques are utilized. For example, 1 kg (2.2 lbs.) of rice requires 1,500 liters (1.06 qts.) of water to produce.

Reasons for Hope

Developed countries use less water per acre of land toward crop yield than developing or emerging market areas, due to more efficient technology and advanced farming practices. This training needs to be passed on for global health and sustainability. Additionally, vertical growth will need to be sought as a solution, since approximately 5.7 hectares (14.1 acres) of land is lost annually worldwide as a result of land degradation and urbanization. Heartier, and more disease- and drought resistant plants that are high yield can be found for future use. Additionally, taking adequate precautions to supply all areas of future megacities with clean fresh water will be a priority to ensure that disease does not infiltrate impoverished sections of the society, as waterborne diseases account for the vast majority of highly transmissible health threats and will bleed into all segments through the food and water supply chain.

Dealing with Human Waste and Sanitation

Sanitation is often an issue even in developed megacities of today. Despite having an adequate food supply and improved water capability, many megacities of the world and areas projected to become future cities are unprepared for the sanitation demands that heavy populations place on urban infrastructure. The current situation highlighted in Rio de Janeiro, Brazil, highlights this very issue. As in

Rio, poor sanitation is directly tied to disease outbreaks among humans. Globally, cholera increased 130 percent between 2000 and 2010, with more than 4 million cases reported each year. The WHO estimates that only 4-10 percent of cholera cases are actually reported. Mass urbanization and water issues only serve to increase diseases such as this. World Bank studies have shown that in Southeast Asia, more than 2 percent of the overall GDP has been lost due to health-related issues linked to poor sanitation, and even more country income potential has been neutralized by poor flood management. To ensure the economic viability of megacities in 2050, effective water and sewage management to assure the health of the populace must be taken into consideration. Moreover, poor sanitation that triggers waterborne outbreaks may not necessarily affect residents of the local area, but it will still impact business continuity through absenteeism and spread of disease to remote locations through the supply chain.

Reasons for Hope

Looking to the future of 2050 and the population challenges that the world will face, technology and collaboration between those responsible for the pillars of infrastructure to support mass urbanization will be the keys to success. Ensuring a safe, sustainable, and adequate supply of food that meets key nutritional needs, an affordable and adequate safe water supply for all for drinking, industrial and agricultural needs, and adequate and safe sanitation for massive and sprawling urban centers that will ensure safety and health security – not just for the immediate local area but for global epidemic control – will be key priorities for global, regional, and local leaders.

Driving in Megacities

As megacities develop and, hopefully, thrive, transportation issues will necessarily arise. The standard model of driving a privately owned vehicle, or even carpooling, to work, will give way to the developing field of car sharing and ride sharing.

- Autonomous vehicle capabilities are increasing rapidly under widespread development by mainstream manufacturers.
- The driving public is likely to join employers in accepting autonomous vehicles as a transportation option when they learn that the personal economic benefits outweigh the detriments.
- Ride-share companies, such as Uber, are seeing exponential growth that does not appear to be abating in the near future.
- Autonomous vehicles bear a security risk that must be mitigated.

Growth of the transportation sharing economy

The transportation sharing economy has grown exponentially over the past decade. Car-sharing companies such as Zipcar and smartphone app-based ride-sharing companies such as Uber (also known as transportation network companies, or TNCs) have attracted millions of members and opened new transportation options in cities across the world.

According to data from the University of California, membership in car-sharing companies grew more than 25-fold in the past decade, from approximately 52,000 members in 2004 to more than 1.3 million in 2014. Growth among TNCs has been even more explosive. According to leaked internal documents published by Reuters in August 2015, Uber expects the total value of ride-share bookings in 2016 to be over USD 26 billion, nearly 38 times higher than in 2013. While some of the ride-sharing growth appears to have come at the expense of car sharing, the overall transportation-sharing economy appears set to continue its rapid growth for the foreseeable future.

The rise of autonomous cars

Researchers have made rapid progress in developing autonomous vehicle capabilities over the past decade. In 2004, the US Defense Advanced Research Projects Agency (DARPA) held its first Grand Challenge for autonomous vehicles. None of the 21 participating vehicles managed to complete more than 5 percent of the 150-mile course. A little over a decade later, in March 2015, automotive component supplier Delphi drove an autonomous vehicle from San Francisco to New York City, with the vehicle in fully autonomous mode for over 99 percent of the journey.

Automakers are investing heavily in autonomous, self-driving cars. Many major automakers, including Mercedes, BMW, Audi, General Motors, Nissan, Toyota, Volvo, and Tesla all have active autonomous vehicle development programs. Several automakers are already producing vehicles with semi-autonomous driving capabilities, and Audi, GM, and Tesla have announced plans to launch models capable of autonomous highway driving by 2016. Mercedes has stated that it plans to launch its first fully autonomous vehicle in 2025. Most major automotive electronics suppliers are also developing autonomous vehicle technology.

Traditional automakers are not the only companies investing in autonomous cars. In 2012, Google acquired a license for the first autonomous car for use on public roads in the United States, and is currently testing a fleet of more than 20 autonomous vehicles on public roads. Google has also designed a purpose-built, self-driving car for use on its corporate campus. Uber has also demonstrated serious interest in autonomous vehicles. In February 2015, Uber opened the Uber Advanced Technologies Center in Pittsburgh to research autonomous vehicle technologies. There are also clear indications that Apple is working on an autonomous car technology.

The legal environment for autonomous vehicles has evolved rapidly in the past five years. In 2011, Nevada became the first US state to legalize testing autonomous vehicles on public roads. Since then, five other states and the District of Columbia have also legalized autonomous vehicles for testing purposes. Similar legislation was pending in seven other states, as of August 2015. The United Kingdom, France, and Switzerland have also allowed companies to test autonomous vehicles on public roads.

Autonomous cars are likely to gain widespread acceptance from the public once the technology reaches sufficient maturity. Public surveys on autonomous cars have shown a wide range of views on the issue, but most have found that the number of respondents who are interested in using an autonomous car is roughly equal to the number of respondents who say they would never use one. Surveys have clearly shown, however, that respondents' interest in using autonomous vehicles is highly dependent on financial factors. Relatively few respondents said that they would pay extra for an autonomous vehicle,

but a much larger percentage said they would consider buying such a vehicle if it reduced the cost of their auto insurance.

Autonomous cars in a transportation sharing economy

Combining autonomous vehicles with the transportation-sharing economy could have a transformational effect on the future of personal transportation by increasing vehicle utilization, lowering the cost of transportation, and significantly reducing personal vehicle ownership. Autonomous vehicles would greatly decrease the cost of ride-sharing services by eliminating the driver's share of the fare. A January 2015 study found that average operating costs (fuel, maintenance, insurance, and car payments) for an Uber driver in Chicago were under USD 4.50 (EUR 3.99) per hour, while the same driver received more than USD 21 (EUR 18.64) in fares per hour. Uber CEO Travis Kalanick has stated that, if Uber were able to use autonomous vehicles, using Uber would be less expensive than owning a car.

The combination of autonomous cars and car sharing could also enable autonomous car owners to earn revenue from their cars when the owner is not using the car, similar to the way in which services like Airbnb allow homeowners to earn revenue from properties when they are not using them. Currently, an average car sits parked for more than 95 percent of its lifetime. With an autonomous vehicle car-sharing service, the vehicle could spend much of that time providing rides and earning revenue for the owner instead of sitting idle, while the autonomous driving capability would get the vehicle back to the owner when the owner needs it.

Benefits of an autonomous vehicle future

Once the technology is fully mature, autonomous vehicles are expected to be safer and more efficient than today's vehicles. A 2015 by the US National Highway Transportation Safety Administration found that 94 percent of road accidents in the US are caused by driver error. While autonomous vehicles are likely to make mistakes of their own, their improved reaction times, strictly logical decision-making, and greater resistance to impaired performance or outside distractions will almost certainly help reduce accident rates. In real-world testing, Google's autonomous vehicle fleet has not reported any accidents caused by the autonomous vehicle, while the fleet has experienced numerous minor accidents caused by other human drivers on the road.

Autonomous vehicles can safely drive closer behind other vehicles, thanks to their near-instantaneous reaction times. Widespread use of autonomous vehicles would greatly increase the density of vehicles on major roads, allowing more cars to pass through a stretch of road during a set period of time. Autonomous vehicles' lower accident rates and more logical decision making would also help cut down on traffic slowdowns and jams. Computers are also capable of driving cars in a more fuel efficient manner than their human counterparts.

For individuals who choose to own autonomous vehicles, the net costs of ownership would likely be significantly lower than today's costs of vehicle ownership. The improved safety of autonomous vehicles would likely bring down auto insurance and vehicle repair costs, and the greater efficiency of

autonomous vehicles would help cut down on fuel costs. The revenue-generating opportunities from autonomous vehicle ride sharing described above would also allow owners to offset a significant portion of the costs of vehicle ownership, and potentially even turn their vehicles into a source of profit without changing the owners' jobs or daily routines at all.

Individuals who choose to rely on ride sharing in a future dominated by autonomous vehicles could also experience significant benefits. Autonomous vehicles would allow ridesharing companies to offer fares that are competitive with current public transportation fares, while offering the convenience of door-to-door transportation, all while enabling the user to avoid the cost of possessing their own vehicle. The individual would have no need for a garage or a parking spot at home, and his or her employer would not have to worry about having a parking spot for the employee at work.

Widespread use of autonomous vehicles also has the potential to add enormous amounts of productivity to the world economy. According to US census data, the average daily commute in the US is just over 25 minutes in each direction. Autonomous vehicles would allow workers to concentrate on work during that time, instead of concentrating on driving, potentially adding nearly an hour per day to each worker's work day.

Risks of an autonomous vehicle future

Widespread adoption of autonomous vehicles will be accompanied by a wave of new technical, security, legal, and ethical risks, however. While such risks can be mitigated, they will require careful consideration by future decision makers. A major issue in a future dominated by autonomous vehicles will be the threat of hacking or other cyberattacks against such vehicles. Hackers have already demonstrated the capability to remotely take over some of a car's functions, and the risks of such attacks will only increase if a car's computers are in full control of the vehicle. The FBI has also warned that autonomous vehicles could present physical security threats, especially if terrorists are able to program them to act as vehicle-borne improvised explosive devices.

The use of autonomous vehicles also raises new legal questions, especially with regard to responsibility for accidents. According to legal experts, in the absence of new legal protections, automakers who manufacture and sell autonomous vehicles are likely to face lawsuits when those autonomous vehicles are involved in accidents, even if the autonomous vehicles are safer than their human-driven counterparts. Legislators and automakers will also have to grapple with ethical questions related to autonomous vehicles' decision-making, such as the choice an autonomous car would make when it has to choose between hitting a small child in the middle of the road or swerving into an inevitable head-on collision with an oncoming car carrying four people. These ethical questions are no different than those faced by humans in similar situations, and autonomous vehicles will almost certainly face fewer instances of unavoidable accidents due to their faster reaction times and ability to consider numerous avoidance options in very little time, but autonomous vehicles' ethical choices are likely to be subject to a higher level of scrutiny than human drivers' choices due to the autonomous vehicle's predetermined and strictly logical decision-making process.

