

Functions of a Large and Complex City

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ABSTRACT

This paper discusses the underlying dynamics of urban change and presents a framework for understanding functions and functional relationships of cities toward supporting of strategic and operational efforts. The work is motivated by the recognition that: (1) new and nuanced geopolitical attention to urban areas is needed as relationships of cities with respect to their home nation states and with respect to other cities are changing; (2) expanding and intensifying urbanization around the world increases the likelihood that future military missions, including adversarial gray-zone activities, will take place in cities; and, (3) urban environments are not neutral terrain and failure to understand military impacts to local residents—including second- and third-order effects—may undermine mission success. In the framework, cities are represented as purposeful, open, complex, and emergent systems. Core functions are identified through a reworking of the Political-Military-Economic-Social-Infrastructure-Information (PMESII) framework from 'what...?' questions to 'how...?' questions.

1.0 THE IMAGE OF THE CITY

1.1 Introduction

Cities have provided enclaves for collective defense,¹ forums for trading goods and ideas,² hubs for territorial administration,³ and loci for spiritual practices⁴ In short, they have been called humanity's 'greatest invention.'⁵ This paper considers the city as a general means to provide societal functions as external factors change and as internal organization evolves. It offers a framework to structure an understanding of critical functions and relationships between and among these functions. Its aim is to enable improved analyses of urban terrain for strategic and operational efforts.

As a preface, this work is offered by someone who does research and who teaches in a school of architecture. From this perspective, a city is a location for various sorts of activities and an object for empirical analyses, but it is not only these things. It is also a site to be purposefully formed and re-formed again and again to meet

¹ G.J. Ashworth, *War and the City* (New York: Routledge, 1991).

² J. Jacobs, *The Economy of Cities* (New York: Random House, 1969); A. Bertaud, *Order without Design: How Markets Shape Cities* (Cambridge, MA: MIT Press, 2018).

³ V. Rossman, *Capital Cities: Varieties and Patterns of Development and Relocation* (New York: Routledge, 2017).

⁴ M. Dumper (ed.), *Contested Holy Cities: The Urban Dimension of Religious Conflicts* (New York: Routledge, 2019).

⁵ E.L. Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier and Happier* (New York: Penguin, 2012).

changing societal needs and aspirations related to the provision of health, safety, and welfare (and, in some instances, morals might be added to this list).

The process of change within a city is always one of negotiation across differing or even opposing values and interests. In part, and as might be expected, there is debate by stakeholders within a city about how resources are developed and distributed. Also in part, and more fundamental, there is debate between a sovereign nation state and its individual citizens about the appropriate mediating role of a city to structure their interactions. Both decisions for change within a city and change in the role of a city must also consider uncertainties, which include normative ambiguities at the root of contested social goals,⁶ epistemological limits of precision or accuracy within competing methods of analysis and the effectiveness of socio-technical approaches to address risk,⁷ and ontological unpredictability that comes with the recognition of unknown unknowns.⁸ The process of change is never-ending because exposure as the negotiated solutions to problems are implemented, new problems with new uncertainties are created. That is, societies meet their present and near-term needs by binding social and bio-physical relationships in time and in space,⁹ but by doing so create new forms of risk that may be exposed in the future.¹⁰ Also, although individual actions might appear to produce only isolated and marginal effects, the changes are cumulative and may lead to complex crises. Examples of the construction and consequences of such risks at the level of the nation state can be found in James Scott's *Seeing Like a State: How Certain Schemes to Improve the Human Condition have Failed*¹¹ and Jared Diamonds, *Collapse: How Societies Choose to Fail or Succeed*.¹²

These observations on the nature of urban change put a gloss on John Spencer's comment that, unlike F. Spencer Chapman's jungle, 'the city is not neutral' terrain¹³ It is not just that the city's population will have abstract opinions about its future; the city, itself, has been physically and socially organized to achieve local priorities. Failure to understand the current organization of a city risks unforeseen second- and third-order effects from military action. Worse, failure to identify topics of intense local uncertainty and understand the dynamics of change in a city risks missing opportunities for intervention before military action might be used.

1.2 The Urban Present and Urbanizing Futures

Continued global population growth and the intensifying concentration of settlement patterns over the second half of the twentieth century and start of the twenty-first century have brought about a new era for cities and a renewed focus on processes of urbanization. The statistics and projections may be familiar to many, but, nevertheless, warrant continued attention. In 2007, for the first time, more human beings lived in cities than in rural areas.¹⁴ Looking forward, it is anticipated that by 2050 over 65% of the global population will live in

⁶ O. Renn, *Risk Governance Coping with Uncertainty in a Complex World* (Sterling, VA: Routledge Earthscan, 2008).

⁷ D. Chandler, *Resilience: The Governance of Complexity* (London: Routledge, 2014).

⁸ M. Mitchell, *Complexity: A Guided Tour* (Oxford: Oxford University Press, 2009).

⁹ A. Giddens, *The Consequences of Modernity* (Stanford: Stanford University Press, 1990).

¹⁰ A. Giddens, 'Risk and Responsibility', *Modern Law Review* 62:1 (1999), pp. 1–10.

¹¹ J.C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition have Failed* (New Haven: Yale University Press, 1988).

¹² J. Diamonds, *Collapse: How Societies Choose to Fail or Succeed* (New York: Viking, 2005).

¹³ J. Spencer, 'The City is not Neutral: Why Urban Warfare is So Hard', USMA Modern War Institute, (March 2020), <https://mwi.usma.edu/city-not-neutral-urban-warfare-hard/>

¹⁴ United Nations Fund for Population Activities, *State of World Population 2007: Unleashing the Potential of Urban Growth* (New York: UNFPA, 2007).

urban spaces¹⁵ and that by the end of the twenty-first century up to 80% of the world's 9–11 billion people will be city dwellers.¹⁶ The growth will be uneven, with most occurring along coastal areas and in developing countries within Africa, Asia, and South America that currently have limited capacities to provide basic services.¹⁷

In broad terms, the process of urbanization will change longstanding spatial organizations and social relationships. Across the developing world, large flows of migrants will transform agricultural villages into market cities of over a million people.¹⁸ In extreme instances, new megacities of over 10 million inhabitants and mega-regions of over 50 million will emerge.¹⁹ Some, such as Shenzhen in China or the Delhi to Mumbai Industrial Corridor Project in India, will continue to be the result of national planning efforts, but most will emerge as rural people and economic migrants seek whatever opportunities they can in the informal economies that operate at the fringes of large cities. In part, the rate at which these new concentrations of people will develop will be dramatic. New York became the first megacity in 1950. By 2014, 28 megacities were home to 453 million people. By 2030, it is expected that there will be 41 megacities that will house 730 million people.²⁰ Also in part, the locations of change will be critical. All of the megacities that emerged late in the last century and in the beginning of the current century were in poor, developing nations, and they reached their size without significant economic gain.²¹ Moreover, none of the anticipated new megacities are expected to be in wealthy nations.²²

At the global scale, likely consequences of such shifts will include the emergence of metropolitan-scale economic zones,²³ new governmental priorities within nation states²⁴ and the reordering of global political influence by networks of cities.²⁵ But, when looking at any specific city, it is an open question if the emerging

¹⁵ United Nations, Department of Social and Economic Affairs, Population Division, *World Urban Prospects—2014 Revision* [ST/ESA/SER.A/366] (New York: United Nations., 2015).

¹⁶ S. Angel, *Planet of Cities* (Cambridge, MA: Lincoln Land Institute, 2012).

¹⁷ B. Cohen, Urbanization in Developing Countries: Current Trends, Future Projections, and Key Challenges for Sustainability, *Technology in Society* 28:1–2 (2006), pp. 63–80; M. Davis, *Planet of Slums* (London: Verso, 2006); B. Neumann et al., Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding—A Global Assessment, *PLoS ONE* 10(3):e0118571 (2015).

¹⁸ G.E. Guldin, *What's a Peasant to Do? Villages Becoming Town in Sothern China* (Boulder, CO: Westview Press, 2001).

¹⁹ F. Pearce, (2006) How Big Can New Cities Get?, *New Scientist* 190(2256):10, (2006); R. Florida et al., 'The Rise of the Mega-Region,' *Cambridge Journal of Regions, Economy and Society* 1:3 (2008), pp. 459–476.

²⁰ United Nations, Department of Economic and Social Affairs, Population Division, *World Urbanization Prospects: The 2014 Revision*, (ST/ESA/SER.A/366) (New York: United Nations, 2015).

²¹ E. Glaeser, *A World of Cities: The Causes and Consequences of Urbanization in Poorer Countries* (National Bureau of Economic Research Working Papers No. 19745, 2013).

²² United Nations, Department of Economic and Social Affairs, Population Division, *World Urbanization Prospects: The 2014 Revision* (ST/EAS/SER.A/366) (New York: United Nations, 2015).

²³ M. Jones, *Cities and Regions in Crisis: The Political Economy of Sub-National Economic Development* (Cheltenham, UK: Elgar, 2019).

²⁴ I. Calzada, 'Metropolitan and City-Regional Politics in the Urban Age: Why Does "(Smart) Devolution" Matter?', *Palgrave Communications* 3 (2018), article 17094, <https://doi.org/10.1057/palcomms.2017.94>; N. Brenner, *New State Spaces: Urban Governance and the Rescaling of Statehood* (New York: Oxford University Press, 2004).

²⁵ W.A. Dunaway, *Emerging Issues in the 21st Century World-System* (Westport, CT: Praeger, 2003); P.J. Taylor, *Extraordinary Cities: Millennia of Moral Syndromes, World-Systems and City/State Relations* (Northampton, MA: Edward Elgar, 2013); S. Graham and S. Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (New York: Routledge, 2001).

conditions will be accompanied by the appearance of novel ways to improve quality of living or the weakening of societal capacities to meet these needs.

The continued occupation of some cities over millennia—such as Athens (Greece), Faiyum (Egypt), Luoyang (China), and Varanasi (India)—gives strong evidence that people living in dense settlements have the ability to adapt to changing social and environmental conditions. However, the collapse of other large and once prosperous urban settlements—including Angkor (present-day Cambodia), Cahokia (present-day USA), Chan Chan (present-day Peru), Kweneng (present day South Africa), and Taxila (present day Pakistan)—underscores the position that the endurance of densely populated areas cannot be guaranteed. There is no evidence that the collapse of these ancient cities resulted in global crises, but the connected fabric of our current world has prompted consideration of the potential impacts of urban failure or collapse to national and international security matters. For example, Richard J. Norton, in his essay, 'Feral Cities,' described the possibility of a globally connected but locally ungoverned metropolis characterized by dilapidated buildings, non-functional infrastructure, overcrowding, disease, pollution, and violence.²⁶ He offered the speculation that such a place could contribute to regional or global security risks by acting as the transshipment point for illicit trade or as an incubator for pandemics. John Rapley called attention to the existence of urban 'statelets,' which might be considered partly feral cities.²⁷ In these places, criminal gangs or extralegal organizations operate in a symbiotic relationship with elected officials of fragile, ineffective national governments. Blocks of votes are exchanged for local autonomy, which includes having the monopoly on violence to preserve order and the ability to exact fees for protection. Such dystopian conditions may not become prevalent around the globe; however, the reality of statelets within relatively weak nation states, the increasing urbanization of developing countries, and the possible materialization of feral cities serve as an impetus to look closely at the ways future urban environments may develop.

2.0 THE CITY AS AN EVOLVING INTERMEDIARY BETWEEN THE STATE AND ITS CITIZENS

The role of the city as a geopolitical unit has changed over history and continues to evolve today. Of central concern for understanding the ways urban areas support national and international order is the role of a city as a mediating organization between its home sovereign state, with its interests in sovereignty and territorial integrity, and individual citizen, with their interests in social freedoms and economic pursuits. The pointed question is: How should the terms for exchange be conceptualized and implemented?

A sketch of this history provides the contours of the dynamics. While the earliest cities date to around 7500 BCE, the current understanding of municipalities can be said to be the Western (or European) twelfth-century medieval town.²⁸ These municipalities were organized by local merchants, who used their economic clout to establish their own social rules and privileges within the layers of feudal control. The fraternal merchant associations served as the body that set and enforced these rules. The associations also served as the source of cohesion for collective, place-based unity. One outcome of vocational- or craft-based agency was the rise of what can be considered town-based identity, or even patriotism.²⁹ That is, economic activity provided a basis for

²⁶ R.J. Norton, 'Feral Cities', *Naval War College Review* 55:4 (2003), pp. 97–106.

²⁷ J. Rapley, 'The New Middle Ages', *Foreign Affairs* 85:3 (2006), pp. 95–103.

²⁸ F. Braudel *Capitalism and Material Life, 1400–1800*, M. Kochan, trans. (New York: Harper Collins, 1975); L. Mumford, *The City in History: Its Origins, Its Transformations, and Its Purposes* (New York: Harcourt, 1961); M. Weber, *The City* (Glencoe, IL: Free Press, 1986 [1921]).

²⁹ F. Braudel *Capitalism and Material Life, 1400–1800*, M. Kochan, trans. (New York: Harper Collins, 1975).

limited governmental autonomy. But the result was more than administrative; it contributed to social identity. Over time, town governance separated from the fraternal orders that had organized them and, therefore, it came to be believed that the towns themselves were limiting individual freedoms. By the mid-fifteenth century, powers of political organization over towns were reassumed by kings. These moves were understood to strengthen state and individual interests. Nevertheless, the role of the town as an intermediary to protect certain kinds of liberty from the state was established.³⁰

As towns and cities grew in size and in influence, so did the debate on their role in preserving the liberties of the individual within the context of a sovereign (and presumed powerful) state. Thomas Hobbs, writing in the mid-seventeenth century at the end of the English Civil War, worried about the possibility that towns could field their own armies in opposition to the commonwealth.³¹ Later in that century, John Locke expressed the opinion that the potential dissolution of municipal corporations by the king amounted to a taking of liberty.³²

Throughout this early period, Western legal systems did not make strong distinctions between public (such as municipal) and private (such as profit-seeking firms) corporations. As such, all corporations could simultaneously be enforcers of rights and liberties and holders of rights and liberties. This view changed in the nineteenth century when municipalities came to be recognized as what we now call public corporations, which are instruments of state-control enforcement. With this move, private corporations were recognized as holding rights that needed to be protected from state interference. One consequence of this distinction is that cities have been and remain relatively weak in political power, but are still recognized as potentially strong for enabling economic the economic agency of private entities. Tensions ensue from the limits cities have to create the conditions of public health, safety, and welfare.

After a series of market failures, the later decades of the twentieth century saw industrialized and developing nations pursue neo-liberalist strategies aimed to reduce government regulation and, thereby, improve economies. While put into practice at the national scale, the moves affected the ways cities were organized and, to a large degree, cities were and continue to be primary sites for the implementing for implementing strategies.³³ The changes have included financial austerity measures and the reduction of central government support for cities, decreasing government oversight and transfer of municipal services from public to private operators and decreasing local rulemaking. Some nations also stopped supporting marginal regions and cities in favour of supporting places most likely to succeed in global competition.³⁴ Broadly, these policies have resulted in increasing movement of capital and, with it, new global-scale spatial patterns across political and economic sectors.

As described above, finance and trade were central to the development of (partial) governmental autonomy in medieval towns. The combination of neoliberalism's deregulation and globalization enable this concern to take on new importance. Further, while the city remains an intermediary between states and citizens, the situation has become more complex with the emergence of global-scale connectivity in finance and trade. Of particular note, cities now make their own international connections. Doing so is not only opportunistic, but strategic though investments in what is called *bridging capital*, which expands capacities for greater interconnection. Such

³⁰ G.E. Frug, 'The City as a Legal Concept', *Harvard Law Review* 93:6 (1980), pp. 1057–1154.

³¹ T. Hobbs, *Leviathan* (New York: Penguin Classics, 1985).

³² J. Locke, *Second Treatise on Civil Government* (Indianapolis, IN: Hackett, 1980).

³³ J. Peck, N. Theodore, and N. Brenner, 'Neoliberal Urbanism: Models, Moments, Mutations', *SAIS Review of International Affairs*, 29:1 (2009), pp. 49–66.

³⁴ W. Salet, A. Thornley, and A. Krekels, 'Institutional and Spatial Coordination in European Metropolitan Regions', in W. Salet, A. Thornley, and A. Krekels, eds., *Metropolitan Governance and Spatial Planning* (London: Spon, 2003), pp. 3–29.

investment can be opposed to a state's investment in *bonding capital* that improves unification through internal supports.³⁵ Patterns of such behaviour highlight the notion that while cities are located in nations, cities are not territorially bound in their actions. Further, the success of cities depends on interdependence of trade flows, not on sovereignty, per se. So, instead of cities being simply a means for change within a nation, they have emerged as a new kind of political entity mediating between individuals and the world. A potential consequence is that by doing so, cities could undermine national cohesion to the degree they pursue their own global-local ('glocal') economic pursuits.³⁶

A net effect of this re-organization or 'rescaling' of statehood³⁷ is a call to expand the academic disciplines of security studies and international relations along with their related professional practices to consider the topic of 'urban security.'³⁸ In general terms, the provision of *security* can be distinguished from the lesser provision of *safety* by the scope of vulnerability and the magnitude of threats. Safety matters are managed by routine police powers of government and include various regulatory mechanisms and government staffs, including police departments. The means and ends of safety are open to debate. Security matters concern existential threats and to declare something a security matter enables extraordinary actions that are beyond routine political debate.³⁹ The reason to add urban as a referent to an ever-growing list of securitizations (national-, environmental-, energy-, food-, water-, and human security) stems from the recognition that dense urban settlements are vulnerable to varied disruptions, ranging from natural disasters to terrorist attacks. Further, given the importance of cities to nations and the aforementioned reach of cities beyond their national borders, these disruptions lead to significant impacts beyond the municipality. But the notion of urban security prompts two competing sets of challenging issues. First, with regard to thinking about how cities serve as intermediaries between the state and its citizens, providing urban security would alter—and very likely limit—the freedoms that cities provide stakeholders. It may also limit a city's ability to make economic connections with other cities within the home nation and in other nations. That is, this approach could seal off a city within a nation state. Second, providing urban security may entail protecting all of the cities within a network of trade, or at least the most important nodes of trade. Doing so could further weaken claims of national sovereignty over a given city. That is, this approach could extricate a city from its nation state.

Another aspect of the changing security environment of urban areas is that some cities have increased their own security-related capabilities and now conduct activities once restricted to nation states. In some instances, they have capacities that (relative to scale) that would be impressive for a state. For example, New York City, with a population of approximately 8.5 million, has a police force of over 36,000 officers and 19,000 supporting employees.⁴⁰ Former Mayor Michael Bloomberg once called this force, 'an army,'⁴¹ and while it serves a very different purpose than a standing military, it is a larger armed unit per-capita than the regular and reserve British Army in the United Kingdom. Also, in the wake of the 9/11 attack and what New York City considered to be insufficient on-going intelligence support from the federal government to protect against emerging threats, it

³⁵ B.R. Barber, *If Mayors Ruled the World: Dysfunctional Nations, Rising Cities* (New Haven, CT: Yale University Press, 2013).

³⁶ E. Corijn, 'Urbanity as a Political Project: Towards Post-National European Cities', in L. Kong and J. O'Connor, eds., *Creative Economies, Creative Cities: Asian-European Perspectives* (Dordrecht: Springer, 2009).

³⁷ N. Brenner, *New State Spaces: Urban Governance and the Rescaling of Statehood* (New York: Oxford University Press, 2004).

³⁸ L.B. Miovska, 'Risk Analysis and Strategic Planning for Managing Urban Security,' *Security Dialogues* 10:2 (2019), pp. 157–167 <https://doi.org/10.47054/SD1920157bm>; K. Ljungkvist, 'Toward and Urban Security Research Agenda in IR', *Journal of Global Security Studies* (2020), <https://doi.org/10.1093/jogss/ogaa019>.

³⁹ B. Buzan, O. Waever, J de Wilde, *Security: A New Framework for Analysis* (Boulder, CO: Rienner, 1998).

⁴⁰ About NYPD (2020), <http://www1.nyc.gov>.

⁴¹ B.R. Barber, *If Mayors Ruled the World: Dysfunctional Nations, Rising Cities* (New Haven, CT: Yale University Press, 2013), p. 6

began stationing police officers in foreign countries to carry out data gathering related to terrorism including tactics used in foreign attacks, names of people suspected of terrorism, their potential connections to New York.⁴² Doing so marks a change in approach with regard to ensuring the protection of its citizens. Typically, city police departments are reactive—they respond when a crime has occurred. In moving officers overseas, it has developed an ability to take anticipatory action. Given New York City's financial resources, it cannot be considered representative of other cities within the United States or of cities in other industrialized nations, but it does provide an example of a city acting in ways that have not been common of municipalities of earlier times.

It should be noted that this summary of the changing status of cities does not portend the demise of the nation state as the primary geopolitical unit for the world. However, it has been argued that in a time of economic globalization, it is increasingly difficult for nation to integrate capital within the geography of their borders; instead national borders will need to be integrated into a geography of capital.⁴³ More pointedly, genuine territorial sovereignty of nation states—as it was originally conceived—is increasingly impossible to assert.⁴⁴

3.0 THE CITY AS A SYSTEM TO PROVIDE BASIC SERVICES

3.1 Representing the City as a System

Multiple metaphors have been used to describe the organization of and workings within cities. Longstanding and influential examples have held that the city is a model of the heavens, a machine, or a living organism.⁴⁵ In the 1960s, cities began to be understood as systems.⁴⁶ An early statement that gave widespread attention to this way of thinking noted that cities display 'organized complexity ... replete with unexamined, but obviously intricately, and surely understandable, relationships.'⁴⁷ Since then, scholars across several disciplines have employed systems thinking to improve the understanding of this complexity.⁴⁸ Broadly, systems provide a way to represent relationships among elements and individual systems can have many different qualities. City systems are: (1) *purposeful*, because they are created to satisfy societal goals; (2) *emergent*, because the behaviour of the whole cannot be reduced to the behaviour of individual elements; (3) *complex*, because individual elements have many relationships with other elements; and (4) *open*, because they exchange energy, materials, and information with their context; and, (5), *self-organizing*, because, they can modify their internal structures or functions in response to external change. Across these qualities, patterns emerge from processes and measures of order can be made. Research on these qualities provides ways to analyse spatial distributions and also what is called 'urban metabolism'—the flows and transformation of energy, materials, and ideas used

⁴² A. Winston, 'Stationed Overseas, but Solving Crimes in New York City', *New York Times* Section A, Page 21, (August 23, 2018), <https://www.nytimes.com/2018/08/21/nyregion/terrorism-nypd-intelligence-crime.html>.

⁴³ N. Brenner, *New State Spaces: Urban Governance and the Rescaling of Statehood* (New York: Oxford University Press, 2004).

⁴⁴ B.R. Barger, *Jihad vs. McWorld: Terrorisms Challenge to Democracy* (New York: Ballentine, 1996).

⁴⁵ K. Lynch, 'Three Normative Theories', in K. Lynch, *Good City Form* (Cambridge, MA: MIT Press, 1984), pp. 73–98.

⁴⁶ B.J.L. Berry, 'Cities as Systems within Systems of Cities', *Papers of the Regional Science Association* 13 (1964); pp. 147–163.

⁴⁷ J. Jacobs, *The Death and Life of Great American Cities* (New York: The Modern Library, 1961), pp. 348–349.

⁴⁸ A. Bertaud, *Order without Design: How Markets Shape Cities* (Cambridge, MA: MIT Press, 2018); T. McPhearson et al., 'Advancing Urban Ecology Toward a Science of Cities', *BioScience* 66, No. 3 (2016): 198–212. doi.org/10.1093/biosci/biw002; M. Barthelemy, *The Structure and Dynamics of Cities: Urban Data Analysis and Theoretical Modeling* (Cambridge, UK: Cambridge University Press, 2016); J. Portugali, *Self-Organization and the City* (Berlin: Springer, 1999).

within a city.⁴⁹ To the degree that the methods produce accurate and precise results, they can inform intentional changes to urban systems through urban policy, planning, and design.⁵⁰

As described above, the function or purpose of cities can, in terms of geopolitics, be considered as mediating relationships between a state and its citizens. For this to occur, conditions within a city must allow large numbers of people—notably large numbers of strangers—to live among each other in close proximity and pursue individual goals. This statement can seem too obvious to need to state, but it is key to approaching a functional understanding of urban areas.⁵¹ Creating an operational systems-model of a city requires an approach that can allow the various basic needs, which can be considered as sub-functions, to be observed and, because city systems are complex, interrelated with one another. It should provide a basis for qualitative discussion, the identification of uncertainties, and the tracking of indicators about system performance.

3.2 PMESII as a Functional Representation of Cities

A framework to characterize the complexity of the built environments used commonly by Western militaries employs six primary variable categories: Political, Military, Economic, Social, Infrastructure, and Information (PMESII). Some implementations expand the framework to include Physical Terrain and Time (PMESII-PT). It was originally developed by the United States Army as a way to identify relevant systems in an operational environment at the geopolitical unit of the nation state. It has been subsequently expanded to understand environments writ large,⁵² including urban environments.⁵³ Standard definitions of the variables are given in Table 1.

Table 1: Conventional definitions of PMESII variables. (Source: US Army, *Training Circular 7-102: Operational Environment and Army Learning* (Washington, DC: Department of the Army, 2014))

Variable	Defining Issue(s)
Political (P)	Describes the distribution of responsibility and power at all levels of governance
Military (M)	Explores the military and/or paramilitary capabilities of all relevant actors (enemy, friendly, and neutral) in a selected operational environment.
Economic (E)	Encompasses individual and group behaviors related to producing, distributing, and consuming resources

⁴⁹ A. Wolman, 'The Metabolism of Cities', *Scientific American* 213:3 (1965), pp. 179–190; C. Kennedy, J. Cuddihy, and J. Engel-Yan, 'The Changing Metabolism of Cities', *Journal of Industrial Ecology* 11(2) (2007), pp. 43–59.

⁵⁰ M. Batty, *Inventing Future Cities* (Cambridge, MA: MIT Press, 2018); M. Batty, *The New Science of Cities* (Cambridge, MA: MIT Press, 2013).

⁵¹ L.H. Lofland, *A World of Strangers: Order and Action in Urban Public Space* (New York: Basic Books, 1973).

⁵² B.M. Ducote, 'Challenging the Application of PMESII-PT in a Complex Environment', School of Advanced Military Studies Monograph (Fort Levenworth: United States Army Command and General Staff College, 2010).

⁵³ [Anonymous], 'The Changing Character of Warfare: The Urban Operational Environment', TRADOC Pamphlet 525-92-1 (Fort Eustis, VA: US Army Training and Doctrine Command, 2020).

Social (S)	Describes the cultural, religious, and ethnic composition
Infrastructure (Infra)	Portrays the basic facilities, services, and installations needed for the functioning of a community or society
Information (Info)	Depicts the nature, scope, and effects of individuals, organizations, and systems that collect, process, disseminate, or act on information

One criticism of the PMESII framework is that it focuses attention on static descriptions or 'what...?' questions and, therefore, while it can provide an inventory of structural features, it does not necessarily lead to more fundamental insights about 'why..?' an environment is organized as it is or 'how...?' goals are achieved. An additional concern is that while relationships of elements within each of the six variable categories and between (or among) categories are assumed, neither formal methods nor heuristic guidance to identify them are offered in the literature.⁵⁴ This lack means that successful implementation depends on the prior knowledge of the analyst. It may also contribute to the isolation of features from their context (sometimes called data *stovepiping*).⁵⁵ Despite these concerns, the PMESII framework is widely known and frequently used. Rather than replace it, modifying it to be allow for deeper consideration of urban systems, including interrelationships between and among the six variables may lead to better analysis.

This revision of the PMESII framework to emphasize functional relationships was initially undertaken to support the NATO Urbanisation Project, a multi-national effort that included participation of subject-matter experts from government agencies, non-governmental organizations, academia, and industry in addition to the militaries of member nations. It has subsequently been updated. It was initiated on the assumption that because most of the world's population lives in urban areas, it was increasingly likely that future military activities—ranging from crisis management and disaster response to stability policing to counterterrorism to warfighting—would take place in cities. It was also recognized that cities in the future would be different than cities today due to the expected effects of climate change, trends in economic globalization, the pace of technological change, and possibility of mass migrations. The general task was to develop methods to understand these transformed environments and concepts that would contribute to successful operations.

The fundamental question, 'why do cities exist?' may not have a definitive answer, but well argued positions have included opportunities for trade, collective defense, and needs for social interaction.⁵⁶ These and other possibilities might be generally subsumed under the notion of providing opportunities to overcome the limitations of individuals. As a thesis to capture a range of opinions for this paper: 'The purpose of cities is to allow strangers to live peaceably and productively among each other.' If this assumption is the purpose of a city, how is it achieved? Table 2 presents a revision to the conventional definitions of the PMESII variables as, 'how...?' questions.

⁵⁴ D. Georgescu, 'Understanding the Situation—Operational Variables and the Direct and Potential Influences Between Them', *Bulletin of 'Carol I' National Defense University* 8, No. 2 (2020), pp. 29–35.

⁵⁵ K.J. McDowell, *The Collective-Action Frame and Emergence: A Better Understanding of the Operational Environment*, masters thesis (Fort Leavenworth: US Army Command and General Staff College, 2013).

⁵⁶ J.K. Brueckner, *Lectures on Urban Economics* (Cambridge, MA: MIT Press, 2011).

Table 2: Alternative definitions of PMESII variables to reflect functional, rather than structural considerations

Variable	Defining Question
Political (P)	How is a member (typically a citizen) identified, what rights pertain to a member, and how do these rights differ from non-members?
Military (M) [Police]	How are security issues defined, declared, engaged, and resolved?
Economic (E)	How do people exchange goods and services?
Social (S)	How do individuals and groups behave and why do they do what they do?
Infrastructure (Infra)	How are flows – of people, food, water, goods, power – coordinated throughout the city?
Information (Info)	How is truth recognized?

These questions about how a city functions are offered provisionally and, importantly, are based on what can be considered a generalist approach to issues that are discussed across geography, urban studies, urban planning and design, and related fields that treat the city as an object for analysis or for composition. There is the intent to pose questions that are sufficiently open that answers can include a great variety and wide variability of elements. The set also allows for the consideration of alternative theories about cause-and-effect relationships that might serve as the basis for any 'how...?' answer. Admittedly, this loose framing may make the application of the framework subject to criticisms that it is inconsistent or arbitrary. The position taken here is that the flexibility is needed, since, if a city is a self-organizing system, then any approach to understanding it must be sufficiently open to accommodate the introduction of unique or unprecedented elements and relationships.

It was noted previously that some implementations of the PMESII framework expand the six primary variables to include Physical Terrain and Time. These additions are not used in this revision, because answering each 'how...?' question involves binding (even if temporarily) contingent system elements in space and in time. Further, it can be expected that these relationships are very specific, if not unique, in each answer. It might also be expected that different activities contributing to the same, 'how...?' question occur at different distances across space and rates of time within a given urban environment.

Another note on the application of the PMESII framework to cities as opposed to nation states concerns differences in the provision of safety and security. Municipalities are expected to provide these protections through police forces that report to mayors or city councils. Additional police forces organized at provincial or national governments might also be deployed within a city. While some of these forces have capabilities that approach those of national armies, they are, nevertheless, civilian by custom and by law. And if military units

are called upon to assist in times of crisis, they typically operate under limited rules of engagement that are far more restrictive than allowed during war. Given these considerations, it could make sense to change the 'M' in PMESII to a second P for police when undertaking urban analysis. It is retained in this paper for convention and to not further double letters in the acronym. It is acknowledged, though, that the Military variable needs to be understood as relating to police and other first responders.

When answering these questions about a specific city, the provincial, national, regional, and global contexts of each variable may also need to be considered. Many aspects of a city will align with the norms and rules of its surrounding territory, but others may differ. For example, special economic zones (SEZs), such as Shenzhen, often operate under different trade and employment rules than other cities in the same home nations.⁵⁷ Because cities are the landing places for most migrants, urban areas may have greater ethnic diversity than surrounding territories and have large ethnic enclaves.⁵⁸ Other contextual factors may not be spatially contiguous. For example, so-called 'global cities', such as London, New York, and Tokyo, are worldwide hubs for the flow of finance and information and may affect or be affected by international events and trends more than by metropolitan area occurrences.⁵⁹

The recasting of the prompts used to inventory and characterize functions within each of the six PMESII variables is followed by an explicit consideration of interactions between the variables. Doing so contributes to identifying interdependencies within the larger system. That is, it aids to understanding of the image of the city as a system-of-systems.⁶⁰ It also provides a way to stimulate consideration of second-order (and perhaps third- and fourth-order) effects of changes to the city. Figure 1 provides a diagram of these interactions. Tables 3–8 restate the base "how...?" question for each variable and provide questions to guide the description of relationships with the other variables.

⁵⁷ K. Easterling, *Extrastate Craft: The Power of Infrastructure Space* (London: Verso, 2016).

⁵⁸ H. De Haas, S. Casteles, and M.J. Miller, *The Age of Migration: International Population Movements in the Modern World*, 6th ed. (New York: Gilford Press, 2020).

⁵⁹ S. Sassen, *The Global City: New York, London, Tokyo* (Princeton: Princeton University Press, 1991).

⁶⁰ D.J. Kilcullen, 'The City as a System: Future Conflict and Urban Resilience', *Fletcher Forum of World Affairs* 36, No. 2 (2012), pp. 19–39.

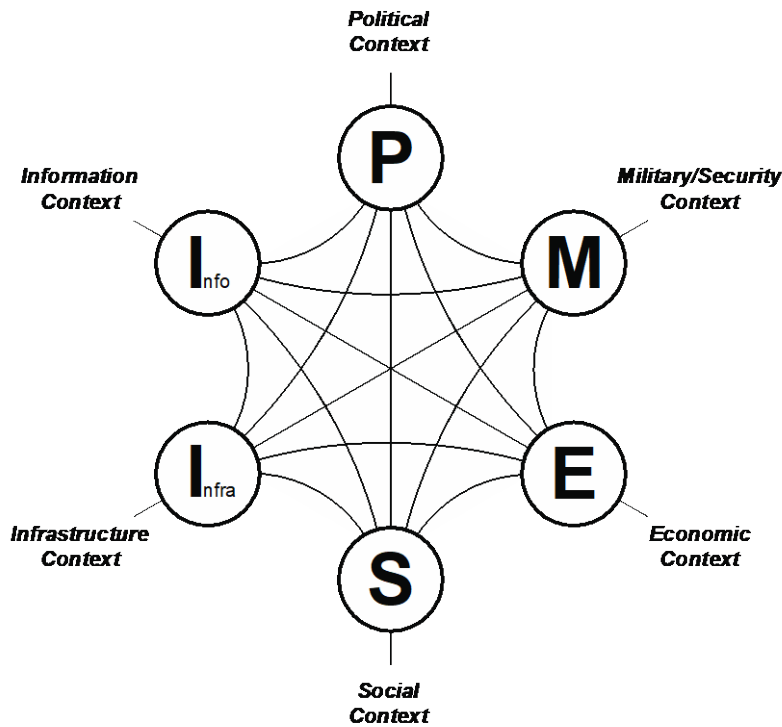


Figure 1: Interaction of PMESII Variables

Table 3: Interactions with Political variables

Variable Interactions	Defining Question
P	How is a member (typically a citizen) identified, what rights pertain to a member, and how do these rights differ from non-members?
P – M	How laws over a population administered and enforced?
P – E	How are regimes of resource distribution structured?
P – S	How is social order legitimized?
P – Infra	How does the state (or city) establish conduits and protocols to direct flows?
P – Info	What counts (that is, numerically matters) and how are counting (inventory) systems constructed and used?

Table 4: Interactions with Military (general security) variables

Variable Interactions	Defining Question
M – P	How are laws over a population administered and enforced?
M	How are security issues defined, declared, engaged, and resolved?
M – E	How are technologies for war and peace prioritized and changed from one to the other?
M – S	How do the institutions respectively associated with the 'two hands on the sword' influence one another?
M – Infra	How is force expanded, extended, and delivered?
M – Info	How is situational awareness sensed and made sense of?

Table 5: Interactions with Economic variables

Variable Interactions	Defining Question
E – P	How are regimes of resource distribution structured?
E – M	How are technologies for war and peace prioritized and changed from one to the other?
E	How do people exchange goods and services?
E – S	How do (social) interests get costed or priced?
E – Infra	How are general, basic services made sharable for specialized production and trade?
E – Info	How are opportunities for exchange revealed?

Table 6: Interactions with Social variables

Variable Interactions	Defining Question
S – P	<i>How is social order legitimized?</i>
S – M	How do the institutions respectively associated with the “two hands on the sword” influence one another?
S – E	How do (social) interests get costed or priced?
S	How do individuals and groups behave and why do they do what they do?
S – Infra	How do people extend their reach and expand their effect?
S – Info	How do people share individual perceptions (facts and opinions, aspirations and fears) with one another and how do they make collectively shared perceptions?

Table 7: Interactions with Infrastructure variables

Variable Interactions	Defining Question
Infra – P	How does the state (or city) establish conduits and protocols to direct flows?
Infra – M	How is force expanded, extended, and delivered?
Infra – E	How are general, basic services made sharable for specialized production and trade?
Infra – S	How do people extend their reach and expand their effect?
Infra	How are flows—of people, food, water, goods, power—coordinated throughout the city?
Infra – Info	How are flows measured, managed, integrated (or separated), and synchronized?

Table 8: Interactions with Information variables

Variable Interactions	Defining Question
Info – P	What counts (that is, numerically matters) and how are counting (inventory) systems constructed and used?
Info – M	How is situational awareness sensed and made sense of?
Info – E	How are opportunities for exchange revealed?
Info – S	How do people share individual perceptions (facts and opinions, aspirations and fears) with one another and how do they make collectively shared perceptions?
Info – Infra	How are flows measured, managed, integrated (or separated), and synchronized?
Info	How is truth recognized?

3.3 Application of the Functional PMESII Framework to Identify Mid- to Long-Term Critical Uncertainties of Urban Areas

As part of the larger NATO Urbanisation Project, ten cities from around the world were analysed to consider dynamics of change. Special attention was given to vulnerabilities and uncertainties that could have harmful impacts on relative stability over the next twenty to twenty-five years.⁶¹ The cities were selected to span a range of readily observable features including geographic location, population size, and economic characteristics (levels of economic development, industrialization, and wealth). The selected cities were: Basra, Caracas, Delhi, Johannesburg, Kinshasa, London, St. Louis, St. Petersburg, Shenzhen, and Tripoli. The revised PMESII framework was used to structure literature reviews on the issues discussed in each city over the previous five years, a time span that was considered as a 'long present.' Government documents, academic papers, reports from organizations and professional consultancies, and articles printed in news outlets were included in the reviews. Contents of the texts were qualified in terms of the topics they addressed and an understanding of each

⁶¹ A.W. Shearer, S. Taybory, and T. Hilde, 'Perspectives on Future Urban Environments', report for the NATO Urbanisation Project (2014).

city's strengths, weaknesses, opportunities, or threats (SWOT analysis⁶²). Given the emphasis of the investigation on potential harms to stability, special attention was given to issues perceived as volatile due to high epistemological uncertainty about the links between causes and effects and normative uncertainty about differing opinions on viable solutions.

Some limitations of this investigation are acknowledged. Notably, sources were limited to materials available on the internet and discoverable through English language searches. Correspondingly, the vast majority of texts reviewed were in English. Also, it was not possible to fully vet the reliability or neutrality of every author. The pursuit of multiple sources and corroborating evidence on any given issue mitigated this concern, but doing so meant the possibility that important minority opinions views were discounted. It must also be recognized that this investigation was qualitative. There were no objective measures or quantifiable thresholds of volatility facing the cities. Instead, the assessments were based on holistic interpretations of observations, analyses, and arguments made by others.

⁶² U. Sosyal and A. Dergisi, 'SWOT Analysis: A Theoretical Review', *The Journal of International Social Research* 10, no. 51 (2017), <https://dx.doi.org/10.17719/jisr.2017.1832>.

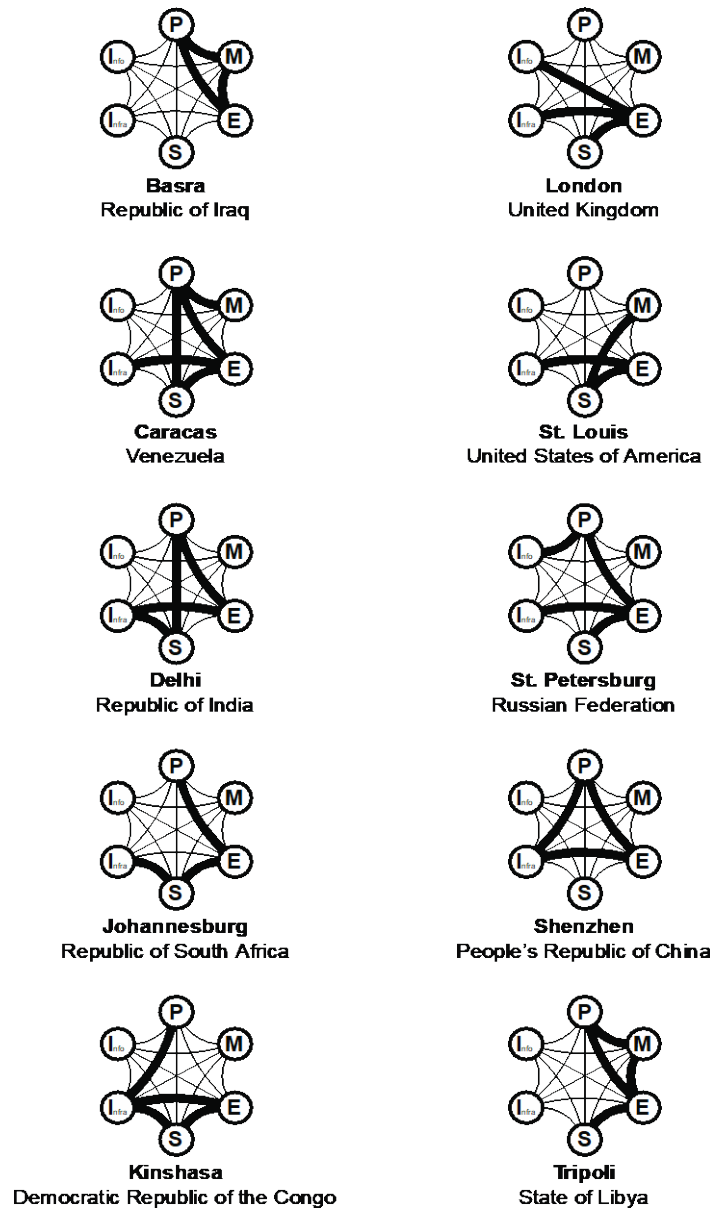


Figure 2: Comparison of case studies based on critical issues facing example cities

The case study cities were selected to provide diversity based on readily identifiable objective measures. The literature review and functional PMESII assessment indicate there is also a diversity of unsettled issues that may influence the future of each. No two cities were assessed as having the same overall pattern of volatile issues, although some cities had one or more topics of volatility in common with others. Another indicator of diversity is that twelve of the fifteen pairwise variable interactions were found to be significant in at least one city. There was no apparent correlation between the objective measures (geography, population size, wealth, etc.) and the identified areas of uncertainty.

4.0 CONCLUDING COMMENTS

No map should be taken for the territory it represents.⁶³ Given complexity of urban systems, this maxim is especially valuable when interpreting the description of a city. Nevertheless, methods to assemble data, produce information, and share knowledge about built environments are needed to take actions that can improve the conditions that allow strangers to live peaceably and productively among each other. These methods should also aid in identifying any harmful indirect effects that might follow from any actions taken to modify the system. The revision of the PMESII framework described in this paper explicitly accepts the assumption that cities are purposeful systems created as populations attempt to solve societal problems. It recasts the definition of the six primary variables from inventories of structural features to explanations about how functional purposes are met. The additional explicit specification of questions about how the primary variables are related to each other contributes to understanding interrelationships of goals. In application, by asking, 'how...?', there is the acknowledgement that the approaches or means to solve societal problems are not universal. The revision also highlights attention on relationships between and among variables, rather than the variables themselves.

The preliminary uses of the revised framework capture some of the dynamic aspects of city systems. The comparison of the ten case studies characterized varying city-wide topics of volatility that would shape the coming twenty to twenty-five years. Still, as a new adaptation of an established framework, more work is needed to test the robustness of the revision. Doing so includes testing the aptness of each 'how...?' question on a larger number of cities. Using archives of a city may allow for the examination of how patterns of perceived problems and activity to address them shift over time.

A final word should be given on the use of the revised framework to consider security in and of urban areas. Although uncertainty typically carries a negative connotation, it is not necessarily unwelcome, since it allows the future to be open. Uncertainty becomes problematic when it is coupled with vulnerability. When extreme uncertainty and extreme vulnerability are combined—that is, when there is existential threat—there is the need to call for security measures. New pairings of vulnerability and uncertainty arise when the context of an open system changes. The greater or the faster the change, the greater the stress; and, the greater the stress, the more likely it will escalate to a security matter and demand extraordinary action. Importantly, there are instances in which societies have identified and adopted policies to manage dangerous situations. By reorganization of the system, new relationships between vulnerability and uncertainty are established and would-be security matters are de-escalated to more routine and more manageable safety concerns. A mundane example is the traffic light, which allows vehicles and pedestrians to negotiate roadway intersections without expected harm. As we think about the futures of cities as purposeful, emergent, complex, open, and self-organising systems, it is possible to make the argument that more attention should be given to identify critical uncertainties and approaches to decrease stress in order to decrease the likelihood that crises will occur.

ACKNOWLEDGEMENTS

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⁶³ A. Korzybski, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics* (Lancaster, PA: The International Non-Aristotelian Library, 1933).

