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The dynamics of urban metabolism in the face of digitalization and changing lifestyles: Understanding and influencing our cities

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ABSTRACT

The world's population continues to grow. With a trend of urbanisation apparent, increasing attention is now being given to understanding and shaping our cities to support an evolving society. Urban metabolism concerns the flows of material and non-material resources and wastes that characterise the functioning and sustainability of a city and which are fundamentally associated with human behaviour. This paper centres upon an examination of how the digital age is supporting and contributing to changing lifestyles and more particularly lifestyle expressions. It shines a light on how a rapidly evolving telecommunications system is influencing, and has future potential to influence, how we participate in society with resultant consequences for urban stocks and flows. In particular, the paper considers the integration of digital technologies into everyday life (digitalization) and their influence both spatially and temporally on our engagement in working, leisure and shopping. It also considers the phenomenon of collaborative consumption in cities (whereby sharing of goods and services, facilitated by digitalization, creates yet further dynamics for urban metabolism). The paper reveals the highly complex and evolving nature of digitalization and collaborative consumption and associated challenges in defining, measuring and understanding the dynamics of human behaviour and social and business practices. In response to this it also considers the underpinning driver of urban metabolism – fulfilment of society's need or desire to access people, goods, services and opportunities. The paper outlines how different paths of urban development are now shaped by the inter-play between our land-use, transport and telecommunications systems and their use in terms of accessibility. Considerations for research and policymaking are highlighted which include the importance of addressing methodological issues in the face of a changing and uncertain future.

1. Introduction

Urban metabolism concerns the flows of material and non-material resources and wastes that characterise the functioning and sustainability of a city and which are fundamentally associated with human behaviour. This paper focuses on the changing nature of how people are living their lives as we move deeper into the digital age. Changing lifestyles are a fundamental determinant of the flows that arise, and will in the future arise, and affect urban metabolisms and their prospects for sustainability.

It is rather obvious that the world is becoming increasingly mobile. People are able to migrate voluntarily or are forced by political, economic and social turmoil in their countries of origin to other parts of the world. Supported by increasing affordability, business and tourist travellers are doing their 'business' elsewhere. At the day-to-day level, citizens are increasingly afforded flexibility in where, when and how they participate in activities as certain spatial and temporal constraints are relaxed and we combine physical travel and digital connectivity to engage socio-economically in society (Schwanen et al., 2008; Alexander et al., 2011). Perhaps paradoxically in this mobile world, urbanisation levels globally are rising, suggesting a growing importance of proximity. Cities, which offer substantial opportunities to have interactions through physical proximity, are becoming increasingly the natural habitat of people (Steffen et al., 2007).

The worldwide economic, social, cultural and political globalisation and integration is a rather recent phenomenon. Yet the world is already from its origin an integrated natural system characterised by a vast collection of interacting physical, chemical and biological processes in the atmosphere, hydrosphere, geosphere and biosphere determining the state and evolution of the planet and life on it (UNEP, 2012). Although

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humans have inhabited our world for more than 200,000 years, since the latter part of the 18th century human-driven emissions have become so pervasive and profound that they appear to rival the natural processes – and so began the Anthropogenic geological epoch (Crutzen, 2002; Steffen et al., 2007).

Cities, as the predominant habitat of the Anthropocene, have a major impact on the earth system: "Urban areas, which house half the world's population, utilize two-thirds of global energy and produce 70 per cent of global carbon emissions (IEA, 2008)" (UNEP, 2012, 18). With population growth and increasing urbanisation, this footprint is set to increase tremendously. Understanding the drivers of social and economic spatio-temporal processes in interaction with the natural spatio-temporal processes in cities is of utmost importance to have options for a balanced future urban metabolism.

Consequently, the aim of this paper is to examine some major dynamics in lifestyles and some pathways for planning to accommodate uncertainty in lifestyle dynamics in the context of sustainable urban metabolism, resulting in recommendations for a research and policy agenda. Two research questions can be derived from this aim. First, "what are the potential implications of *digitalization* [1] and *collaborative consumption* for urban metabolism?" Changes in lifestyle orientations and expressions will affect future movements of people, consumer products and information as well as the nature of consumption. This could have large implications for the consumption of energy and other natural resources and the production of waste. Information and Communications Technologies (ICTs) have permeated into many people's urban lives and might affect the frequency and spatio-temporal pattern of physical activities and physical travel. The recent upsurge in collaborative consumption, which is related to increasing use of ICTs, holds the prospect of yet further (unknown) impact on urban metabolism (Botsman and Rogers, 2010).

"How can we accommodate *uncertain lifestyle changes when planning for accessibility* in the context of sustainable urban metabolism?" is the paper's second research question. Lifestyle changes take place in urban forms which change relatively slowly. There is a need to ensure that evolution of urban form is both flexible and resilient and occurs in such a way that uncertain longer-term futures for lifestyles and associated physical and digital connectivities can be accommodated and supported. At the same time, sustainable urban metabolism should be safeguarded. This calls for an appreciation of how society's fundamental needs and desires for access to people, goods, services and opportunities are fulfilled – through a combination of physical mobility, digital connectivity and spatial proximity – in a sustainable way. There is also a need to embrace the uncertainty over future access in terms of societal preferences and affordability – something which scenario planning offers a means of doing through its ability to foster group thinking, challenge preconceptions and account for key drivers of change in the development of plausible, divergent futures or pathways (Lyons et al., 2014).

By studying relevant literature, both research questions are addressed. In the next section, urban digitalization is discussed, followed by a section on collaborative consumption. In the fourth section the focus is on different pathways for urban development and their implications for urban metabolism. This paper is especially relevant for urban metabolism researchers from different scientific disciplines as well as policymakers addressing urban metabolism issues. In the interest of both target groups the paper concludes with a discussion of the key emergent issues and their implications in terms of future research and policy priorities.

[1] The integration of digital technologies into a set of activities or processes – in the context of this paper, into everyday life.

2. Urban digitalization

It would be difficult to overstate the impact that ICTs have had on modern life. Countless activities that in the past could only be conducted in person, over a land-line telephone, or by physically transporting a document or other object, can now be conducted digitally and/or remotely. In addition, ICTs have created numerous new activities that do not have close counterparts in the "pre-modern-ICT" era. Consider the following list of new or transformed activities, as only a small sample of the whole: teleworking, video meetings, monitoring the well-being of a dependent family member through a "nanny-cam", massive open online courses (MOOCs), multiplayer online games, online bill-paying and investing, income tax preparation, interacting with government agencies, communicating with social and professional networks, travel planning and purchasing, working or playing while travelling, music and video entertainment consumption, book/magazine/newspaper reading, photography, retailing, buying or renting a home, remotely controlling home utilities, and finding a personal service provider. Wearable computing, robotics/automation, and virtual and augmented realities are continuing the revolution. Although the geographic reach of these innovations is constantly growing, due to economies of scale they are often available first and most effectively within urban concentrations. Thus, without question, flows of bits and bytes within the urban metabolism have grown exponentially and forms of consumption of time and resources and of interaction have diversified and continue to do so.

In this section we first outline some of the research associated with selected "digitalized activities" that have been the subject of particular academic interest in relation to their implications for lifestyles and travel demand, namely teleworking, teleleisure, and online shopping. We then examine a key consequence of urban digitalization: the spatio-temporal fragmentation of activities enabled by ICT in general and the mobile Internet in particular. We touch on how the picture varies with socioeconomic characteristics such as age and income, and finally speculate on some implications for use of resources and production of waste. To keep the scope manageable, the focus throughout is on the *consumption* choices made by end-users, and as such we neglect a vast landscape of ICTs involvement in the *provision* of goods and services (manufacturing, transport, health care, and so on).

2.1. Teleworking

The past several decades have seen increasing portions of the jobs of white-collar information workers being digitalized, alongside the share of the workforce holding such jobs increasing markedly. Accordingly, telecommuting – working from home or from a location closer to home than the main workplace, in lieu of the regular commute – has long been promoted as an important tool for reducing peak period travel, with the accompanying benefits of reducing congestion, emissions, and fuel consumption among others.

A major challenge associated with studying teleworking is that the term can be applied to a number of rather diverse work arrangements (Mokhtarian and Tal, 2013) which in turn illustrate the collective complexity of lifestyles. The words "telecommuting" and "teleworking" are often used loosely, without defining what they mean in any particular context. However, the various forms of teleworking differ dramatically in their impacts on travel (and thence urban metabolism):

- from generally saving it in the case of *substituters* (the classic "telecommuters" – salaried employees substituting working at home for commuting) and *telecentre-based workers*; to
- mostly neutral in the case of *supplementers* (those who bring work home to do on overtime), *remote back office workers*, *field workers,* and *home-based self-employed workers*; to
- facilitating more travel in the case of *mobile workers*, and possibly in the cases of *long-distance telecommuters* and *distributed team members*.

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