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Seven Critical Directions for Integrated Land Use–Transport Models

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Abstract

This paper summarizes the workshop discussion on "Integrated Models" organized during the 11th International Conference on Travel Behaviour Research in Kyoto in August 2006. The workshop focused on urban land use models and their integration with transport and activity models. As the companion resource paper offers an excellent and detailed summary of the state of the field and literature, our report primarily summarizes the discussion at the workshop. Historical critiques of land use models, which framed the workshop discussion, are briefly reviewed, and seven critical research directions that emerged are highlighted.

Introduction

The workshop discussion was framed by a few key papers. The first is the workshop's resource paper by Miller (2009) entitled "Integrated urban models: theoretical prospects," which provides a thorough review of the state of the art, the literature, and the research issues. Miller referred to previous critiques of land use models by Lee (1973, 1994) and by Timmermans (2003). As much of the discussion in the workshop responded to these critiques, below we summarize their criticisms, comment briefly on the current state of the art as reflected in the workshop discussion (refer to Miller, 2009 for further detail), and finally highlight the critical research directions that were emphasized by workshop participants.

Framing the Discussion: The Critiques

Lee (1973) framed his early critique of urban land use models in terms of seven deadly sins:

1. *Hypercomprehensiveness*: There is a tendency to attempt to do too much with one model, resulting in a model that does not serve any specific purpose very well.
2. *Grossness*: The models are built at too high a level of aggregation.
3. *Hungriness*: The models require oppressively large amounts of data, making them impractical for practitioners to implement.
4. *Wrongheadedness*: The models are wrong, both theoretically and practically. They are not grounded in theory, and they do not serve the needs of urban policy makers.
5. *Complicatedness*: The models are far too complicated for practitioners to understand or work with, and the benefit of the complexity is often unclear.
6. *Mechanicalness*: The models are ad hoc with no theoretical basis.
7. *Expensiveness*: The cost of developing a model far exceeds available resources at planning agencies.

Two decades later, Lee (1994) updated and further summarized his original seven deadly sins, emphasizing the importance of asking and answering the following two fundamental questions (paraphrased by Miller, 2009):

1. *Are we doing good science?* Are the models based on sound theory? Are we making systematic progress in the field?
2. *Are we doing good engineering?* Are we answering the questions that are asked by urban planners? Are we producing tools that are useful?

More recently, Timmermans' (2003) critique similarly emphasized the lack of behavioural underpinnings for the models. Additionally, he highlighted the reluctance of researchers to take on the following major challenges in the field: spatial choice processes, context and domain specificity, integration of decisions made in different time horizons, and emphasis on policy analysis rather than forecasting.

Finally, Miller (2009) provided detail on how progress in the field has addressed the Lee and Timmermans critiques. Significant progress has been made. Grossness has been tackled most successfully, albeit at the cost of complicatedness and expensiveness. With respect to the question of good science, there is still need for improvements in theoretical grounding: key behavioural components, such as spatial choice, integration over time, and the supply side, have not been adequately addressed. With respect to the question of good engineering, still at issue are hypercomprehensiveness, hungriness, and complicatedness. In general, the critiques offer conflicting objectives requiring

balance and trade-offs: making progress along one dimension is often costly along another.

Looking Forward: Seven Critical Directions (and Seven Memorable Quotes)

In terms of future research directions, among workshop participants, there was general agreement that Lee's questions regarding good science and good engineering should motivate and direct future progress in the field. Furthermore, as many of Lee's critiques are fundamental to integrated modelling, they are still in the forefront today. Nevertheless, the workshop discussion highlighted seven specific critical directions to pursue in the development of integrated transport–land use models. We characterize them using seven "deadly" quotes from workshop participants:

1. "*Who meets who in what bar leads to marriage*." With theories of human agents and agent-based frameworks, the field is rapidly progressing in terms of behavioural realism. Important areas of emphasis include the integration of joint decisions (e.g., travel with work and residential location), the incorporation of psychological factors (e.g., motivation, triggers, attitudes, learning, adaptation, and social influences), and moving beyond naive spatial choice models. However, in pursuit of this finer level of detail, it is important to avoid a "downward spiral of disaggregation." What is gained in terms of policy analysis? Is it necessary to model couples meeting in a bar? Clearly not. The research question remains of where to draw the line. This balancing act between complexity and practicality requires more attention as we incorporate more behavioural detail in our models.
2. "*I don't get up in the morning and decide where I'm going to work*." A complicating factor of integrated models is the presence of a wide variety of decisions made over diverse time scales. The interactions across short-term (e.g., departure time), medium-term (e.g., non-work destinations), and long-term (e.g., mobility bundle and residential location) decisions have been, at best, weak and ad hoc in existing models. Theories need to be developed to frame the interactions, for example, considering short-term decisions as actions that occur *now* with fixed resources and long-term decisions as those that change those fixed resources.
3. "*Have you ever heard of demand AND SUPPLY?*" Toward the end of the workshop, it was noted that the supply side of the equation had not been mentioned. As in our discussion, the focus of the field has been predominantly on household behaviour. However, the behaviour of supply side firms and developers is just as critical when attempting to accurately forecast urban trends. There are deficiencies in our understanding of the drivers of land development and building supply. Furthermore, the interaction between supply and demand in price setting mechanisms tends to be either non-existent or ad hoc, rather than based on

economic theory. Such economic aspects are one of the weakest links in transport–land use models.

4. "*I'm glad SOMETHING is exogenous*." A key decision in developing integrated models is where to draw the model boundary. This includes both the geographic boundary and the boundary of integrated components (e.g., demand/supply, households/firms/developers, transport/land use, passenger/freight, highway/transit, microeconomics/macroeconomics, etc.). The research question is what types of integrations are worthwhile and for what purposes. The issue is one of "combinatorics" versus payoff: broader geographic areas and more components significantly increase model complexity and the resulting benefits are often nebulous. Workshop participants agreed to draw the geographic boundary around the urban area, excluding inter-urban interactions. In terms of the components, discussion highlighted the desire to break from a one-size-fits-all mentality and have the model purpose drive model specification. This would result in simpler, more transparent models. However, concern was expressed that a piecemeal approach would work against objectives of collaboration, standardization, and scientific progression.
5. "*When I finish the model, I'll name it MYMODEL*." The participants noted the issue of competition versus cooperation in the field. Because model development is so resource intensive, it is associated with tremendous start-up costs and often results in propriety models. As a community we need to learn and progress in a more open and systematic way, and infrastructure needs to be developed that facilitates such progress. One push in this direction is Opus (see www.urbansim.org), an open source platform using the R programming language that aims for plug and play components and contributions from a host of researchers. While software infrastructure is one key component to systematic progress, another is having a common dataset (or datasets) that can be used to directly compare different model formulations.
6. "*If we require 20 years of detailed panel data to get where we want to be, then we all need to get a new career*." The discussion noted the common lament that we are always inhibited by the limitations of available data. We need to reconcile with the fact that we will never have the perfect dataset and employ more creative uses of extant data, for example: accessing data from web sources (e.g., trolling real estate sites), using imputation and data mining, and archiving data to ensure we save what we gather.
7. "*Integrated models are the holy grail*." In the workshop, we repeatedly returned to the question of "so what?!" Why do we need such complexity? Why do we need the models at all? As a community, it is important that we clearly define the value of integrated models and demonstrate their worth to urban planners and policy makers. For success, the workings of the models need to be such that they can be made transparent to this intended audience. Relevance to urban planners and policy makers must drive development for the models to have real impact.

Conclusion

Although historical critiques of integrated models have been harsh, the feeling at the workshop was that the glass is half full, not half empty. Progress has been made, and a bounty of research opportunities remains. Furthermore, there are methods and theories available to more fundamentally ground our models. The workshop discussion highlighted seven critical directions for future research: balancing the level of behavioural detail with practical use, integrating temporal decision-making scales, incorporating supply mechanisms, defining model boundaries, increasing research collaboration, overcoming data limitations, and demonstrating value. In pursuing these directions, as a community, our work must be informed by the fundamental questions of: Are we doing good science? Are we doing good engineering? Integrated models address all issues of importance in urban areas, including the environment, air quality, climate change, congestion, economy, infrastructure development, and quality of life. Therefore, ''while the task may be difficult, the reward is great!''

References

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