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A Pathway Linking Smart Growth Neighborhoods to Home-Based Pedestrian Travel

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A Pathway Linking Smart Growth Neighborhoods to Household-level Pedestrian Travel

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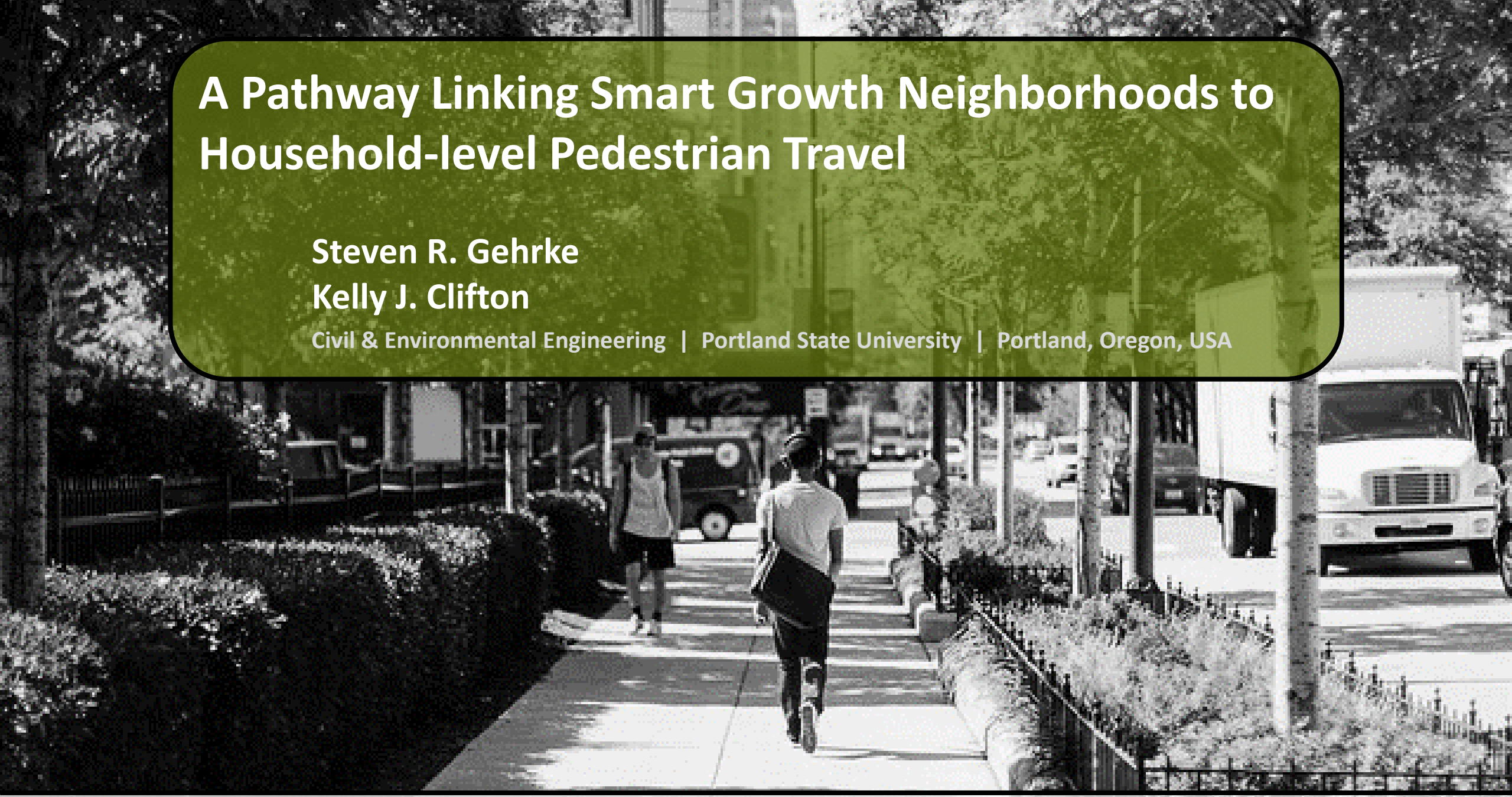


Research context and motivation

Land development patterns and urban design linked to travel behavior

- Smart growth policies and practice create activity-friendly, walkable communities
- Policy goal in 2009 Interagency Partnership for Sustainable Communities

Need to identify built environment indicators and set common standards

- Past active travel studies have adopted imperfect built environment measures
- Host of individual, societal, and contextual factors are hypothesized to predict walking behaviors for transportation and recreational purposes

Compact Development

High Activity Density

Walkable Design

Study objectives

Introduce a multidimensional construct of the built environment

- Reflect several heralded tenants of smart growth development
- Offer insight into measurement selection and packaging of different elements

Propose framework and method linking this construct to pedestrian travel

- Simultaneously account for various and confounding determinants of walking
- Extend understanding of link between smart growth development and walking

Structural equation models (sem) of transport-land use link

Individual perceptions of built environment

- Explore themes of neighborhood accessibility, arrangement and aesthetic, and sense of place to recognize their influence on auto ownership and mode choice
- Subject to reporting bias that may inflate connection and difficulty in translation

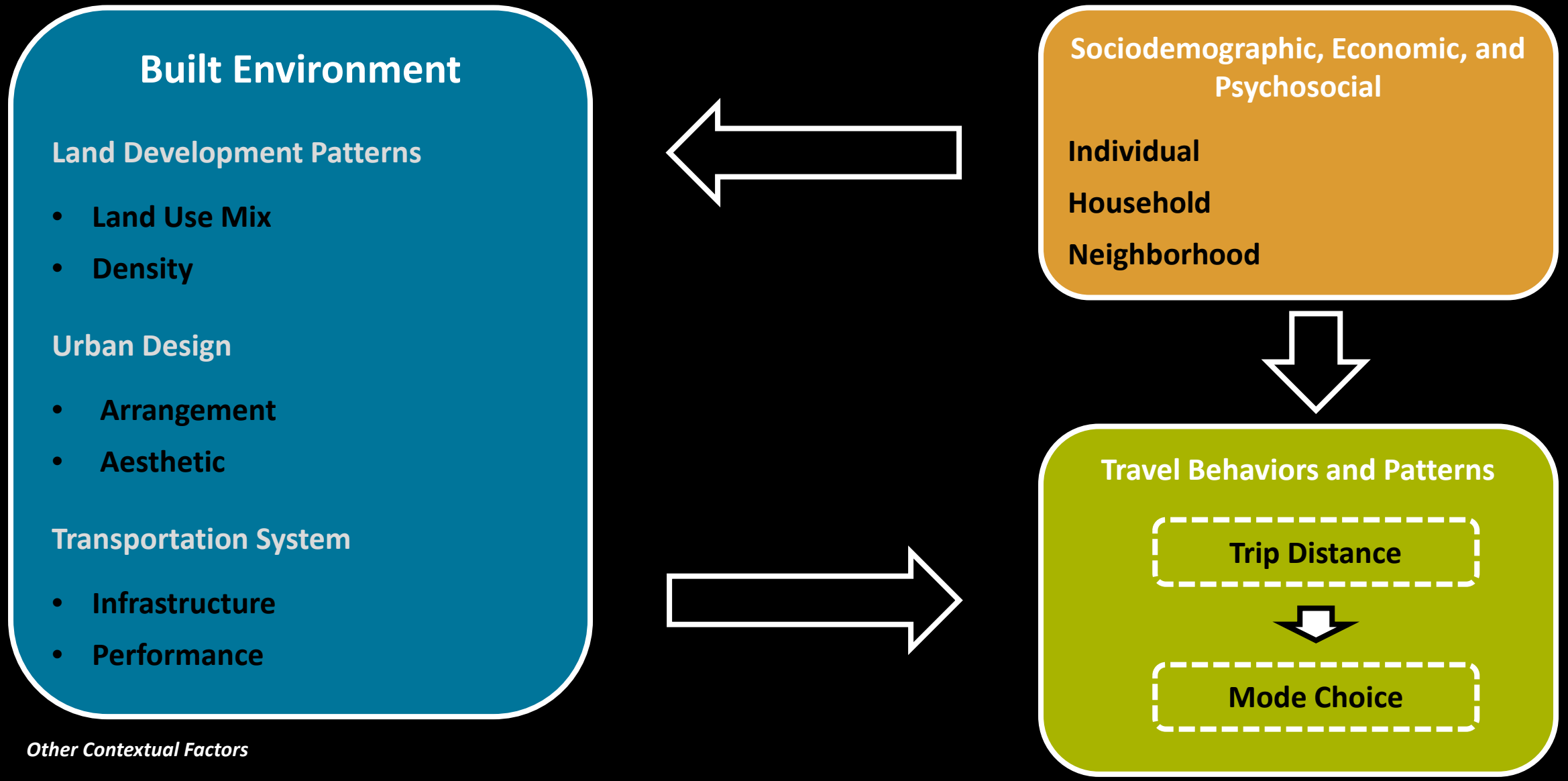
Objective measures of built environment

- Early studies explored limited number of indicators to reflect land use construct
- Recent studies test more indicators to examine short- and long-term decisions

Important gaps

- Few SEM studies exclusively reflect built environment with objective measures
- Studies largely examine built environment impact on auto-related outcomes

Conceptual framework



Data and methods

Study area and sample

- Multnomah, Clackamas, and Washington Counties in Oregon
- 2011 Oregon Household Activity and Travel Survey (OHAS)
  - One-day travel diary for a study sample of 4,416 households
  - Travel behavior and sociodemographic and economic information

Built environment measurement

- Set of 62 indicators measured within a one-mile areal buffer at home location
- Secondary data sources
  - 2011 Portland Metro Regional Land Information System (RLIS)
  - 2014 Longitudinal Employer-Household Dynamic (LEHD)
  - 2010 US Census and Topologically Integrated Geographic Encoding and Referencing (TIGER)

Built environment measurement

Built Environment

Land Development Patterns

- **Land Use Mix**
- **Density**

Urban Design

- **Arrangement**
- **Aesthetic**

Transportation System

- **Infrastructure**
- **Performance**

Land Use Mix: Composition

- Land use percent for nine land use types
- Land use entropy index
- Land use balance
- Activity-related complementarity
- Employment entropy
- Employment-population balance
- Retail employment-population balance
- Land use patches for nine land use types

Land Use Mix: Configuration

- Maximum patch size for nine land use types
- Maximum patch size (overall)
- Contagion index

Built environment measurement

Built Environment

Land Development Patterns

- **Land Use Mix**
- **Density**

Urban Design

- **Arrangement**
- **Aesthetic**

Transportation System

- **Infrastructure**
- **Performance**

Density

- Population
- Housing units
- Employment
- Office jobs
- Retail jobs
- Industrial jobs
- Service jobs
- Entertainment jobs
- Total activity (population and employment)

Built environment measurement

Built Environment

Land Development Patterns

- **Land Use Mix**
- **Density**

Urban Design

- **Arrangement**
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Transportation System

- **Infrastructure**
- **Performance**

Urban Design and Transportation System

- Census blocks
- Street blocks
- Connected node ratio
- Alpha index
- Beta index
- Gamma index
- Three- and four-way intersections
- Cul-de-sacs
- Miles of primary, secondary, and local roads
- Percent of primary, secondary, and local roads
- Sidewalk coverage

Analytic approach

Zero-order correlation matrix

- Eliminate associated measures that point toward concept redundancy

Exploratory factor analysis

- Identify sets of interrelated measures reflecting built environment dimensions
- Generate theoretic understanding of internal structure of measures

Structural equation modeling

- Confirmatory factor analysis
  - Identify latent constructs of built environment reflecting multiple indicators
- Path analysis
  - Simultaneously test for direct and indirect effects of built environment on pedestrian travel

Confirmatory factor analysis

Built Environment

Land Development Patterns

- Land Use Mix
- Density

Urban Design

- Arrangement
- Aesthetic

Transportation System

- Infrastructure
- Performance

0.97 — Activity-related complementarity

0.54 — Employment entropy

0.87 — Maximum patch size: Agricultural *

0.86 — Maximum patch size (overall) *

0.94 — Contagion index *

CFA Fit Statistics: CFI: 0.96 | TLI: 0.91

** Reverse Coded*

Confirmatory factor analysis

Built Environment

Land Development Patterns

- Land Use Mix
- Density

Urban Design

- Arrangement
- Aesthetic

Transportation System

- Infrastructure
- Performance

0.83 — Employment-population balance

0.91 — Office jobs

0.87 — Retail jobs

CFA Fit Statistics: CFI: 0.99 | TLI: 0.99

Confirmatory factor analysis

Built Environment

Land Development Patterns

- Land Use Mix
- Density

Urban Design

- Arrangement
- Aesthetic

Transportation System

- Infrastructure
- Performance

0.92 — Land use patches: Retail

0.91 — Connected node ratio

0.72 — Sidewalk coverage

CFA Fit Statistics: CFI: 0.99 | TLI: 0.99

Structural equation model

Built Environment

0.63

0.53

0.85

Smart Growth Neighborhood

SEM Fit Statistics: CFI: 0.85 | TLI: 0.80 | RMSEA: 0.08

Sociodemographic and Economic

- Number of children under 6 years
- Number of children 6 years or older
- Number of adults
- Non-related household
- Annual household income
- Number of household workers
- Oldest household member
- Highest household educational attainment
- Vehicles per licensed adult
- Transit passes per adult
- Bikes per person 6 years or older

Travel Behaviors and Patterns

Trip Distance

- Walk Mode: Transportation
- Walk Mode: Discretionary

Results: Walk for transportation purposes

Outcome: Household-level decision to participate in ≥ 1 home-based walk trip for *transportation* purposes

Indicator Name	Direct Effect	p-value	Total Effect
Number of children under 6 years	0.04	0.05	0.04
Number of children 6 years or older	0.15	0.00	0.15
Number of adults	0.10	0.00	0.07
Annual Income: $50,000 to $99,999	-0.06	0.04	-0.06
Annual Income: $100,000 or more	-0.08	0.01	-0.11
Household workers: 3 or more	-0.05	0.01	-0.05
Education: Graduate degree	0.05	0.10	0.09
Vehicles per licensed driver	-0.05	0.00	-0.11
Transit passes per adult	0.00	0.90	0.01
Bikes per person 6 years or older	0.03	0.04	0.06
Smart Growth Neighborhood	**0.22**	**0.00**	**0.26**

Results: Walk for discretionary purposes

Outcome: Household-level decision to participate in ≥ 1 home-based walk trip for *discretionary* purposes

Indicator Name	Direct Effect	p-value	Total Effect
Number of children under 6 years	-0.02	0.34	-0.02
Number of children 6 years or older	0.06	0.01	0.06
Number of adults	0.08	0.00	0.05
Annual Income: $50,000 to $99,999	0.03	0.24	0.01
Annual Income: $100,000 or more	0.01	0.84	-0.01
Household workers: 3 or more	-0.04	0.03	-0.04
Education: Graduate degree	0.05	0.09	0.07
Vehicles per licensed driver	-0.02	0.12	-0.07
Transit passes per adult	-0.03	0.04	-0.02
Bikes per person 6 years or older	0.02	0.27	0.04
Smart Growth Neighborhood	**0.15**	**0.00**	**0.17**

Conclusions

Study contributions and potential implications

- Introduced second-order construct of smart growth reflecting three key tenets
  - Provided planners an identified set of indicators reflecting built environment efficiencies
  - Guide land development discussion away from contentious debates focused on density
- Demonstrated link between smart growth residential environments and walking
  - Strong direct and total effect on household-level choice to participate in a walk trip
  - Highlight continued prospect of smart growth policies facilitating more physical activity

Next steps

- Additional non-built environment variables and complexity to SEM analysis
  - Sociodemographic and economic characteristics as formative construct
  - Hierarchical framework to model individual-level travel behaviors
- Further attention to choice of geographic scale used to operationalize indicators

Thank you. Questions?

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