Using AI to bring walkable cities to life

PAWS for thought:

AI and big data reveals what makes people walk in urban centres

PAWS
Place and Walking System

vivendi consulting
bringing your vision to life

At a glance

The **Place and Walking System (PAWS)** uses AI to learn how over 100 variables determine walking in Greater Sydney. PAWS can predict walking at around 90% accuracy.

This is the first model of its kind.

Findings

- **Structural variables -** those that are in-built to the design of a centre - explain **over half** of the observed walking.
- **Demographic factors** account for around **a** quarter of walking volumes.
- **Adaptable** factors, such as public transport, trees, road speed, account for less than 20% of walking.
- Walkable centres have at least **45 intersections per km²**, and at least **70% of housing** as flats or apartments.
- There are **six pillars of pedestrianism** that collectively explain and predict most of the observed walking in 140 centres in Sydney:
  - Housing
  - Employment
  - Destinations / points of interest
  - Public transport
  - Population characteristics
  - Footpath network connectivity
- Up to 20 other factors also have limited influence.

Application

- The PAWS model diagnoses how to improve walking in each of Sydney's 140 centres.
- It helps decision makers understand what effect population, housing, employment and other projects will have on walking.
- It provides a robust and proven evidence base.

PAWS

Introduction

What would you change about your local town that would encourage you to walk more?

People love answering this question, and responses are many and varied: more destinations near to where I live; less traffic; walks that are leafy, interesting, flat and easy; close to public transport (to get home with shopping); streets that have life but are not too crowded...

The factors that influence walking are many and complex. Also, as we know, what people say and what they do are very different.

This complexity makes it difficult to understand what *actually* encourages walking in the 'real world' – let alone understand which factor is most important, and how factors may work together to promote or hinder walking.

In a time where governments are looking to adapt our current largely car-based cities to ones that encourage more walking – particularly around local centres – this information is vital.

Fortunately the availability of 'big data' as a by-product of everyday behaviour, along with sophisticated data analytics, allows us to start to find answers to these profoundly complex problems.

PAWS

Place and Walking System

In pioneering work done in collaboration with Transport for NSW and other state agencies, Vivendi Consulting used anonymised 'big data', sophisticated geospatial analysis and machine learning data analytics, to objectively reveal what makes local centres walkable – and why.

This analysis, called the Place and Walking System (PAWS), started by looking at 117 variables that previous studies found could explain walking. These variables were grouped into:

- **Structural:** features that are 'inbuilt' into a centre and difficult to change. This includes variables such as the type and density of housing and jobs, the street pattern (as a measure of ease of getting from A to B); how centres are designed and laid out and the number and quality of attractions and places to walk to.
- **Adaptable:** these are features that can more easily be changed, such as traffic speed, bus and train public transport, trees and green cover.
- **Demographic:** the number and type of people who live in the centre, including age, gender, income, employment, families, car ownership.
- **Environmental:** rainfall, temperature, topography

We collected this enormous set of data from 179 centres across NSW over the course of 18 months.

This 'world first' analysis provides robust data about how urban form, transport networks, demographics and environment influence walking, using big data and AI.

"Without data, you're just another person with an opinion"
W. Edwards Deming

The Data Science

Unravelling patterns of urban walking using a range of AI technology

So – we have over 100 factors that determine whether people walk (the independent variables). The other part of the puzzle is how much people are actually walking (the dependent variable). To understand this, the model used Transport for NSW anonymised mobile phone location data (comprising billions of individual data points), carefully analysed for each of the 179 centres. This 'observed preference' of people's behaviour provides a sufficiently accurate picture of 24/7 walking in each centre over the course of an entire month.

So – we know which variables influence walking, and we know how much people walk: how do we put the two together to find out how each of these variables influences the amount of walking in a centre?

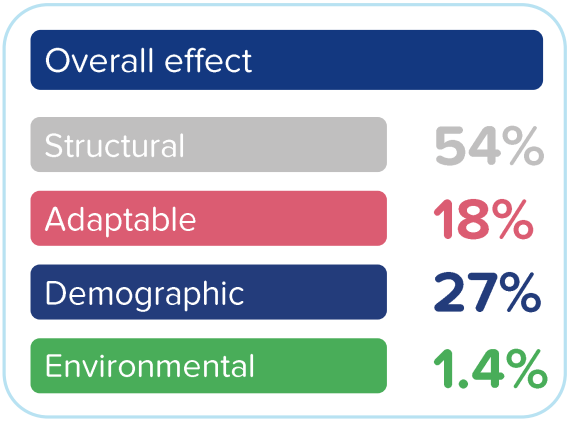
This is where modern **data analytics** has been able to help us pick through the enormous complexity to understand how the variables work, individually and together, to influence walking. The PAWS model uses a range of **machine learning and neural network analysis**, combined with some techniques to look 'inside' the machine learning model and make sense of the huge data set.

Urban design dictates walking

Where there are people, destinations and a direct route, people will walk

Our findings support academic studies that find that 'structural' factors – such as housing and employment density, permeability and points of interest – account for the majority of walking. In Greater Sydney, these factors explain around **54%** of the observed walking. (Note these 'overall effect' numbers over-simplify what is a complex story – but they are helpful nonetheless).

This should not be a surprise: where there are lots of people, lots of destinations and it's easy to get there on foot, we would expect to see a lot of walking.



Population demographics explained around a **quarter** of the total observed amount of walking, and environmental factors in Greater Sydney explained a surprisingly small **1.4%.**

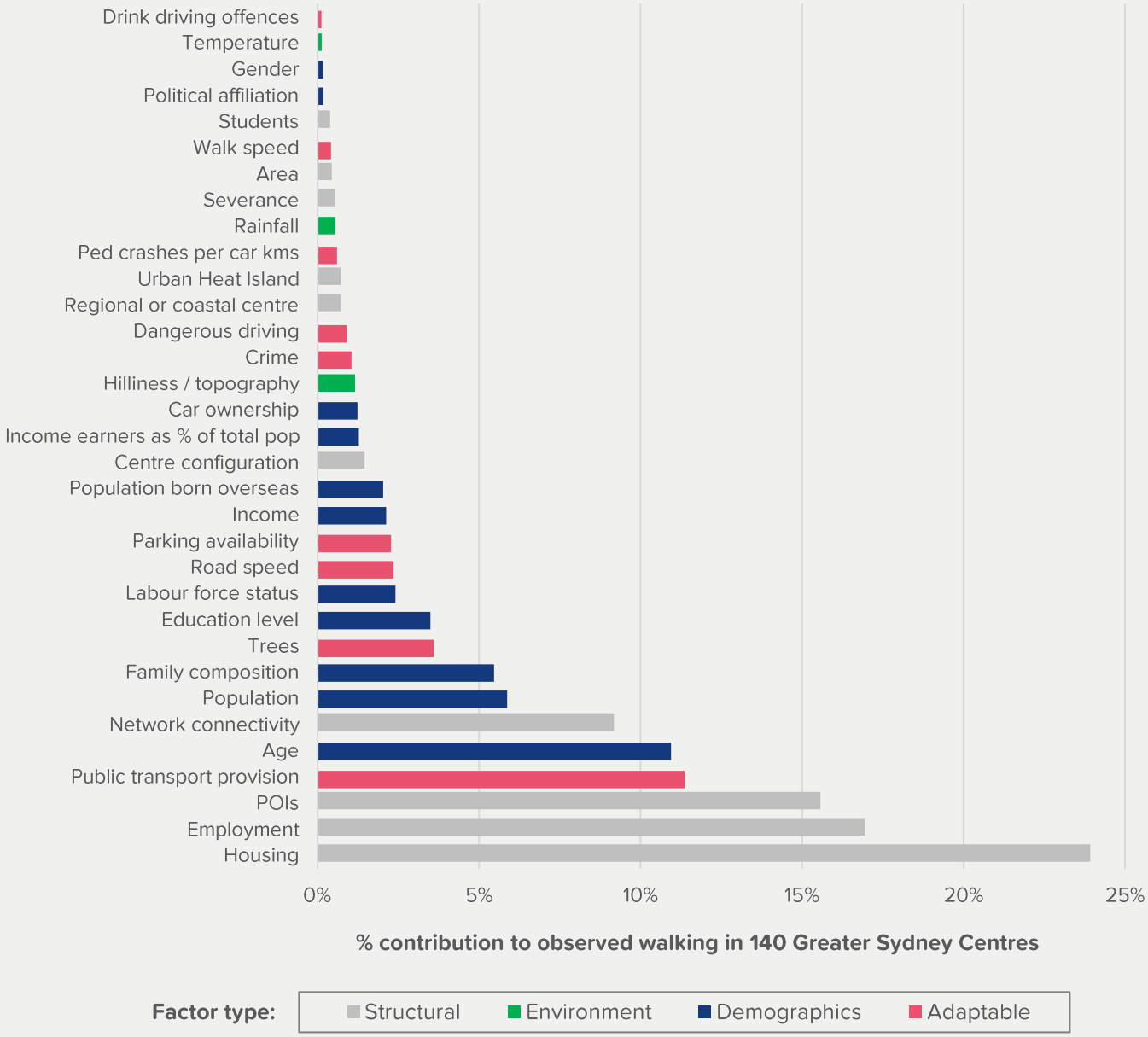
What is notable is that Adaptable factors – such as trees, public transport, traffic speed – accounted for **less than one fifth** of the total observed amount of walking.

In short, where there lots of people, destinations for them to walk to and it's easy for them to get there, people will walk. While this sounds obvious, it is a truism that is often overlooked by planners when trying to retroactively improve places and make tradeoffs.

While these effects have been identified through some impressive Australian research (see Billie Giles-Corti and Annie Matan), this work demonstrates these effects empirically and on a large scale.

Six pillars of pedestrianism

Six factors are key in predicting walking



PAWS shows there are 6 key 'pillars' that determinants of walking:

- **Housing type and density**: flats and apartments are strong predictors of walking
- **Employment**: high volumes of jobs tend to encourage walking
- **Points of Interest** (POIs): more, better quality destinations attract walking
- **Public transport** provision: train and bus services
- **Age**: centres with a higher proportion of working age people tend to be more walked
- **Network connectivity**: well-connected walking facilities enhance walking activity

‘Tipping points’ for walkability

Tipping point 1: walking network connectivity

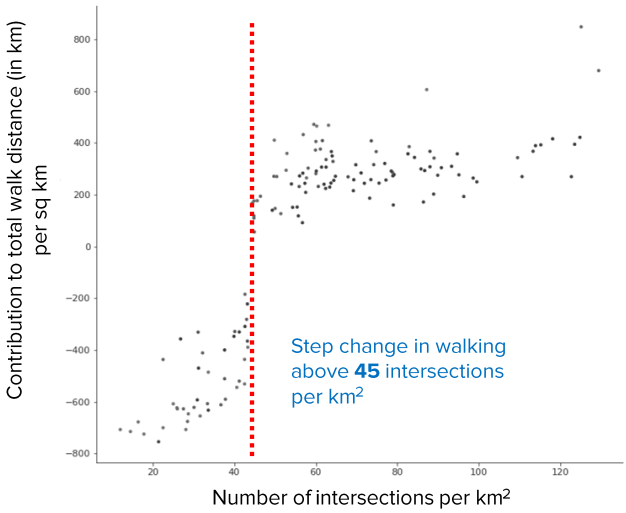
A key measure in the ‘structural’ category is the **number of intersections per km2**. The more intersections, the more ‘fine grained’ and permeable the walking network, allowing people to reach their destinations more directly with limited deviation.

Fine-grained network: encourages walking

Coarse-grained network: suppresses walking

One other fascinating finding from our work was that higher amounts of walking are observed in centres with at least 45 intersections per km^2 (across both ‘inner’ and ‘outer’ areas of centres – an approximately 2 km radius). Below 45 intersections per km^2, walking was suppressed.

The urban design implication is clear: if we want walkable centres, we must plan for at least 45 intersections per km^2.



Walkable centres have at least 45 intersections per km^2

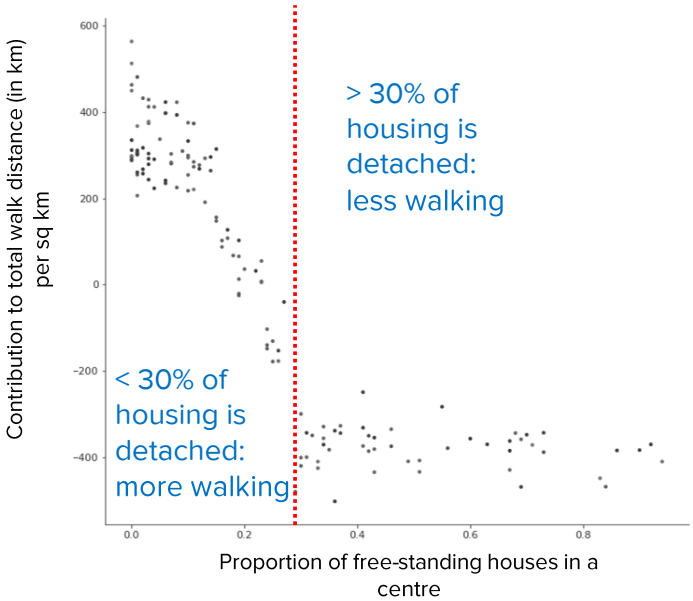
‘Tipping points’ for walkability

Tipping point 2: housing type

Highly walked centres have no more than 30% of detached houses; the remaining 70% are flats, apartments or semi-detached houses.

The effect is so strong there is a **‘tipping point’**: centres with more than 30% of detached houses have suppressed levels of walking, regardless of whether housing is 30% or 100% detached.

Walking is sensitive to the proportion of detached housing below 30%: the lower % of detached houses, the more walking. This finding has a clear lesson for urban planning: if we want walkable centres we need to provide a maximum of 30% detached housing (i.e. at least 70% flats and apartments). Below 30% the less detached housing the more walking.



If we want walkable centres we need to provide a maximum of 30% detached housing

From pavement to property prices

Pedestrians create prosperity - which is reflected in land value

In theory, more vibrant and pleasant locations result in higher numbers of pedestrians, which attract retail and commercial activity and which in turn increases the value of land in these centres.

Our work supports this view. We found that **walking volumes are correlated with land value (r=0.72).** For Sydney, we found that every km walked per month in a centre is associated with a **26c per m² increase in land value.**

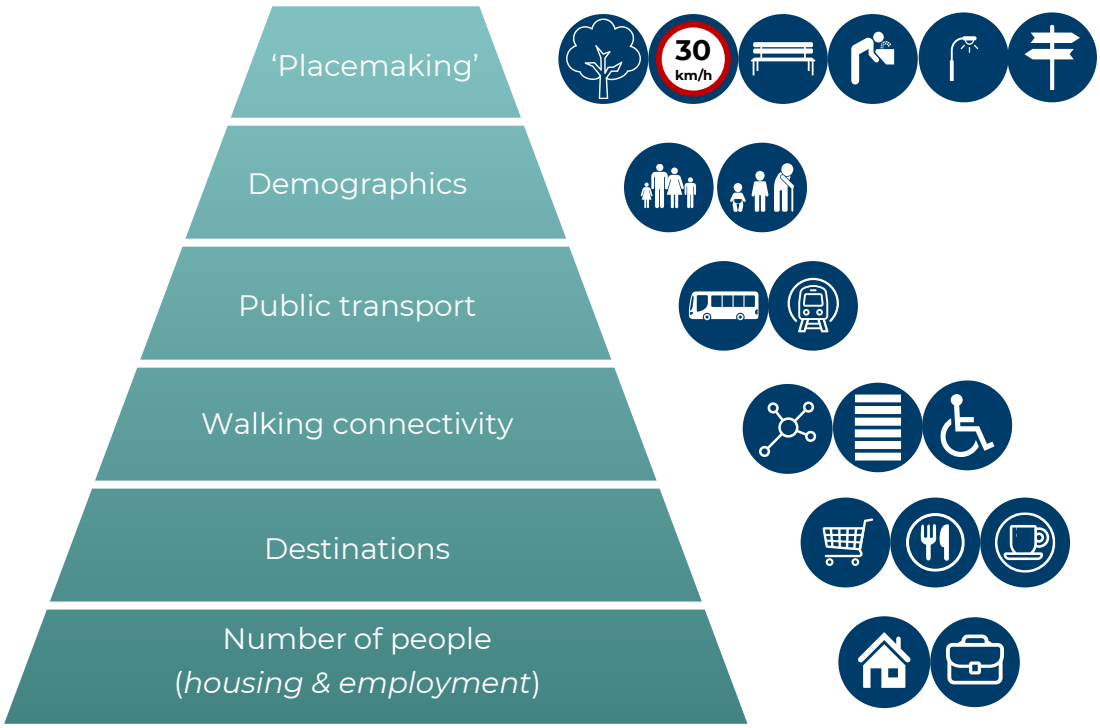
As always, correlation does not always mean causation, and there may be some confounding factors. Nevertheless, the relationship appears strong and has a robust underlying logic.

This finding has the potential to cut through difficult economic evaluation questions about valuing 'amenity' in place and precinct plans. Walking also has significant broader benefits to a population's physical and mental health, the environment and wider society.

Every km walked per month correlates with a 26c increase per m² in land value

So what does this mean?

How to think about increasing walkability in urban centres



1. If we want to see people walking more around our centres, the '**fundamentals' are vital** – the right kind of housing, mixed land use with different attractions and a layout that makes it easy to walk from A to B.

2. These '**fundamentals' tend to be inbuilt when centres are designed**. It's either difficult or time-consuming to retrofit structural walkability (e.g. smaller block sizes, more density, more mixed land use). If we want people to walk around our centres, these structural factors should be included as a priority in designing new centres, or in redevelopments of brownfield centres.

3. Making **'adaptable' placemaking interventions** in centres that already have the walking fundamentals in place will lead to more walking.

To be clear, it makes sense to improve walking everywhere, making it safe, connected and accessible for all – but **creating places with the 'fundamentals' already in place will be far more effective** and provide better value for money than trying to retrofit walkability.

These conclusions are not new – but the PAWS framework provides robust, objective, empirical evidence across a large number of centres. It can even predict changes to walking for Greater Sydney centres.

Who needs PAWS?

PAWS highlights pitfalls and finds potential

The PAWS model is used for much more granular analysis. It helps identify centres that are **'under-walked'** and **under-valued**, that would benefit from improvement. For each centre, it can :

- Create a **'walkability diagnosis'** to identify the strategic improvements will result in more walking *(e.g. change housing density zoning; increase bus stops and services; reduce traffic speed on key roads; increase mixed-use zoning).*
- Describe the **impact** these changes will make on walking volumes in the long term.
- Provide **strategic design directions** to match the demographics of the resident population – ageing populations, families with young children or areas where people have to drive for work have very different needs..
- Predict **how walking will change in each centre** based on around 100 variables. This includes changes to housing density, land use, transport networks – and even demographics.

The outputs of PAWS is **uniquely reliable, objective evidence-based information** to support land use and transport decision-making. Our clients find this essential when preparing walking and / or cycling strategies.

Next steps

As far as we know, this is the first time this kind analysis has been conducted, using this volume of data and modern analytical approaches. We are continuing to develop the model, and the pull out many more insights that are available, and there is still a great deal of work to do.

We have developed other AI models that:

- analyse walking and cycling at a route level, using image recognition and deep learning: the **Cognitive Mobility and Place System (C-MAPS).**

- analyse safety risk to pedestrians: the **Pedestrian Safety Assessment Tool (PedSAT).**

We are continuing to develop these and other AI models that examine how people respond to their environment, using learnings from this work.

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About Vivendi Consulting

Bringing vision to life

We bring people together to solve difficult problems, using the right information to make difficult decisions.

The firm has over a decade of experience in delivering challenging strategies, operations improvement, business cases, projects, change programs and cutting-edge data analytics.

Nick Fletcher, Vivendi Consulting Director

Nick has a 20-year career delivering challenging strategies, operations improvement and data analytics projects for government agencies in the UK, Europe and Australia.

Contact Nick on: **nick.fletcher@vivendiconsulting.com**

This article is published with the permission of Transport for NSW.

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