Travel behaviour and the future of transportation systems - from the COVID era to the technology era

Future of Urban Mobility in the Context of Societal Challenges conference

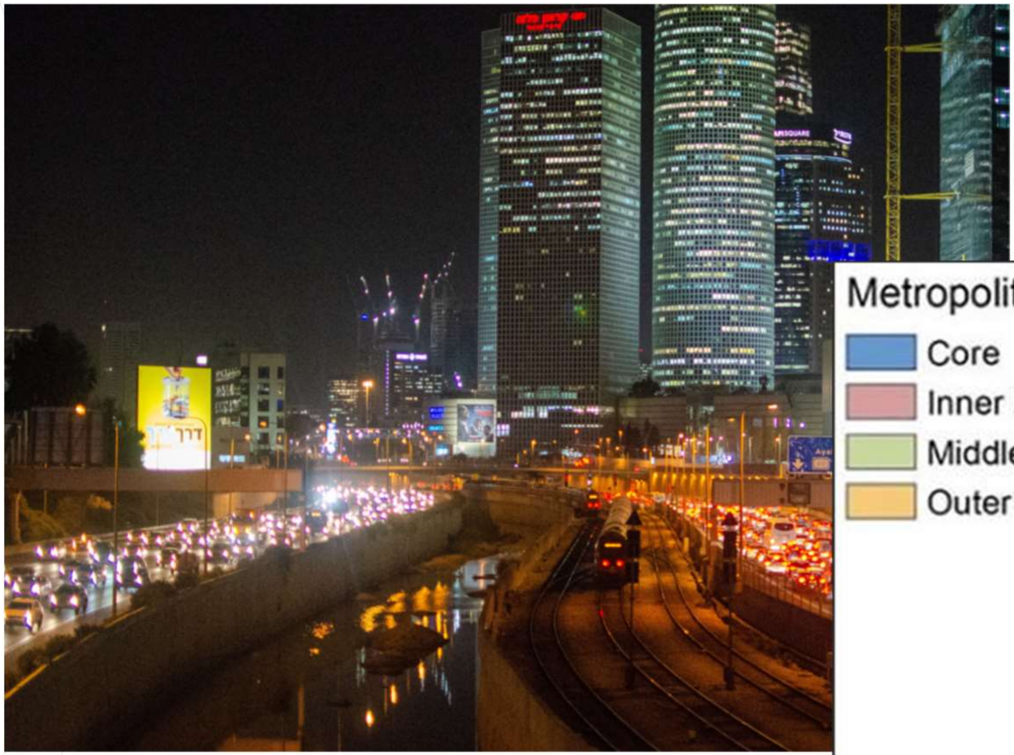
Prague, Oct 19, 2022

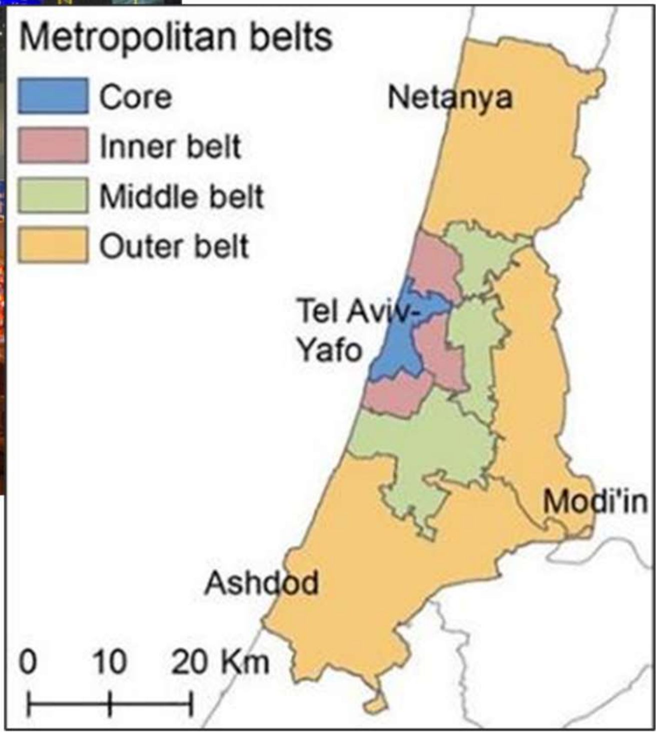
Outline

- Motivation – the Tel Aviv Mass Transit System
- COVID impacts
- Automated and Connected Vehicle/MaaS – Behavioral impact
- Congestion pricing
- Mobility and the City 2100

Tel-Aviv Metro Case Study

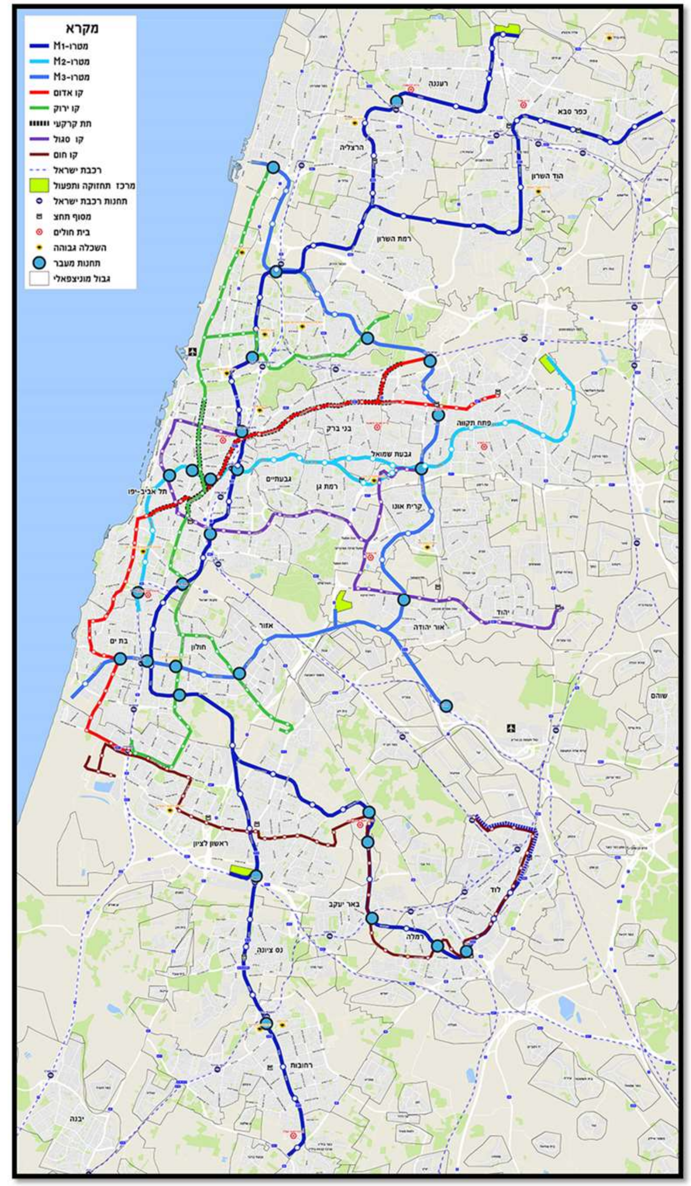
- Population: : 4 Million
- 44% of the population and 50% of the employment in Israel
- One of the most congested metropolitan areas in the world (21st according to TomTom).
- Population growth rate 2% in the last decade
- Estimated population in 2040: 5.4 Million





The Final Plan

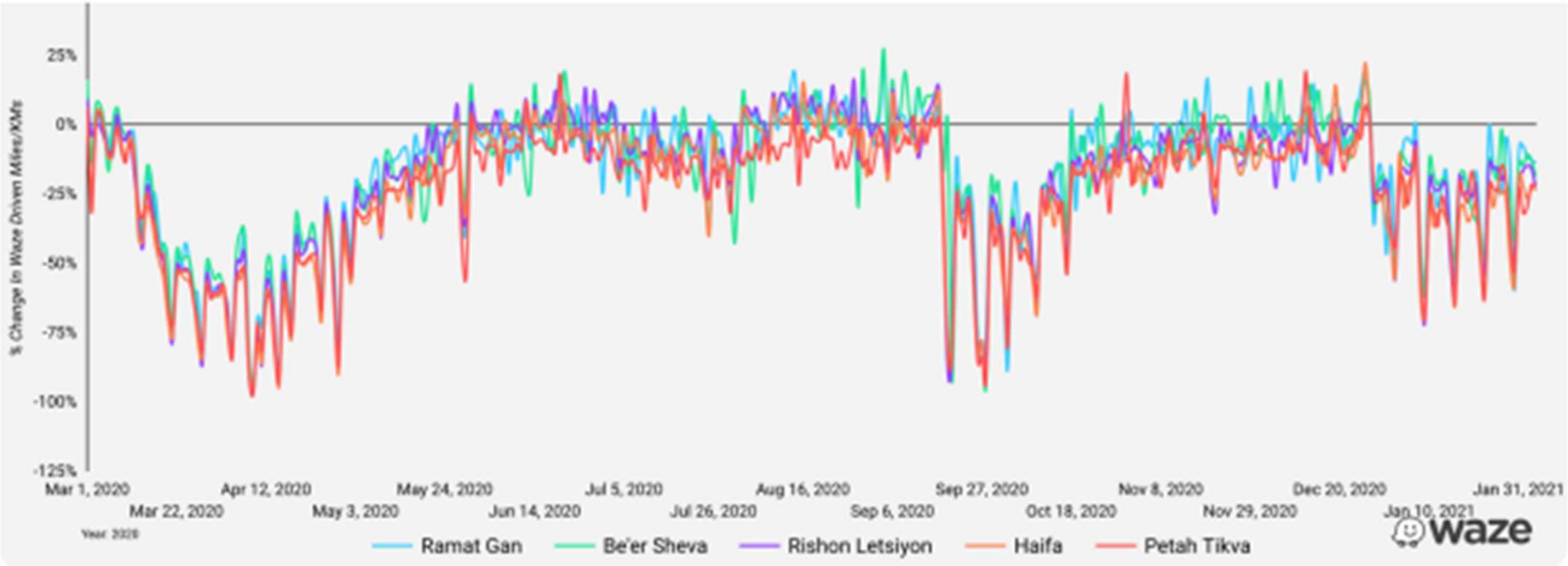
- A metro system of 3 lines serving the Core, Inner Ring and Middle Ring of the TAM
- 3 LRT lines: Red (under construction), Green and Purple
- 3 BRT lines: Brown Line, HaSharon Line and Light Blue Line
- Suburban rail lines.



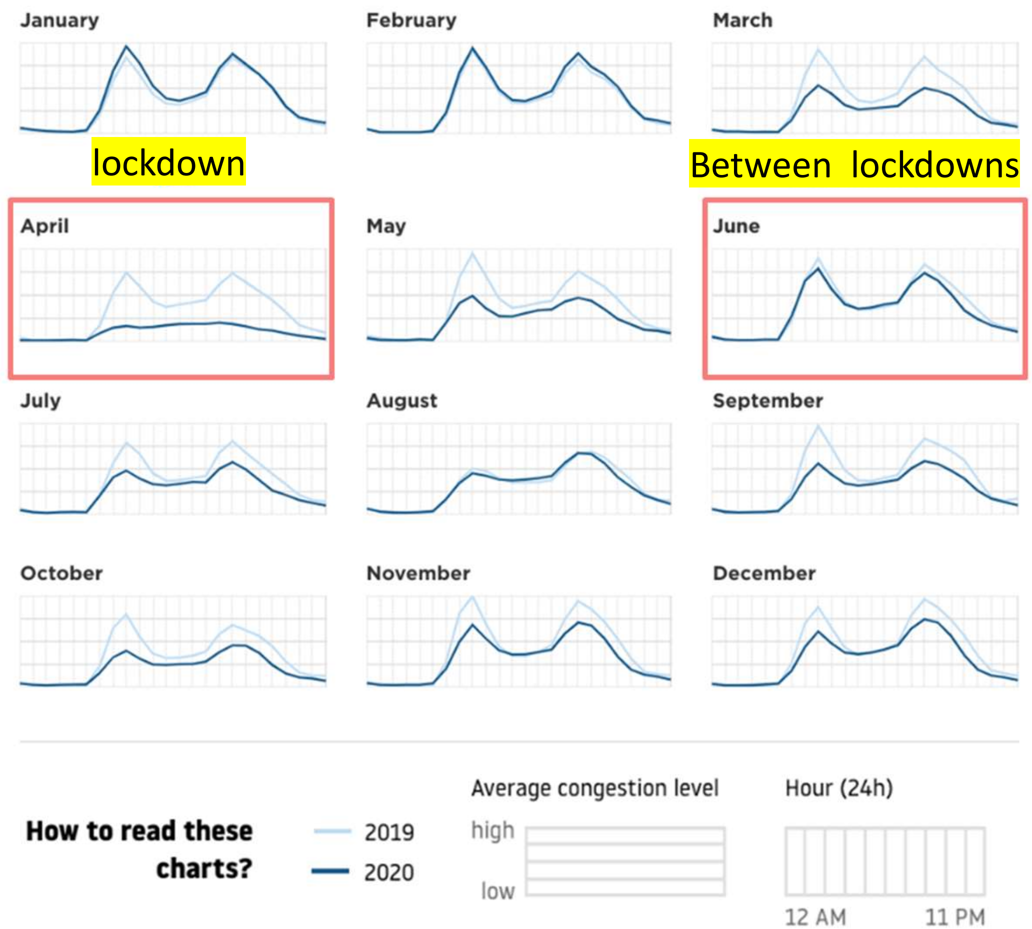
The Critique Various Trends

Covid and Traffic

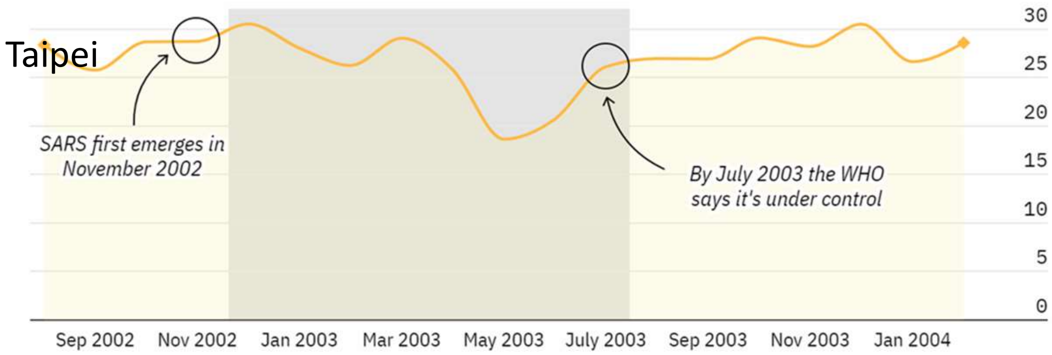
As lockdowns are lifted, car trips tend to return to pre-covid levels (waze, 2021)

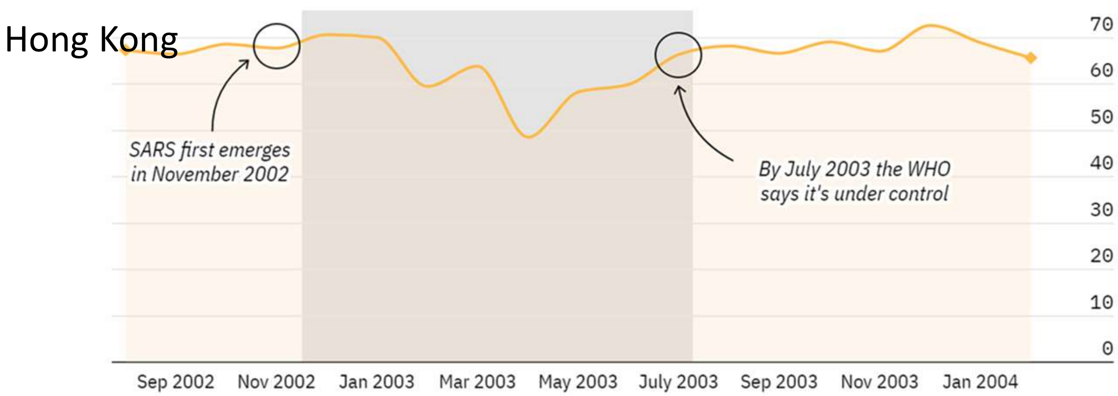


Traffic during Covid



The SARS impact on Mass Transit





Joint Israel Czech Research

First lockdown

April – May 2020

First Survey

- Personal Data
- RP – Before Covid
- RP/SP – While lockdown
- SP – After Pandemic

2,400 Participants

June 2020

Second Survey

- RP – After first lockdown
- SP – After Pandemic

2,000 Participants

July 2022

Third Survey

- Changes in personal Data
- RP – After lockdown

1,070 Participants

Relevant Set (those who answered all three surveys):

860 Participants

Work From Home (Hours)

Relevant Set: 860 Participants

Relevant Participant – One who got available information about SP choices in April 2020 and June 2020, and RP record in June 2022.

Remote Work/Study (from home)

	RP Pre Covid	SP for after COVID	RP
		June2020	June2022
Zero hours	469	402	328
0-5 Weekly hours	163	137	96
5-10 Weekly hours	91	126	136
10-20 Weekly hours	56	77	120
20-30 Weekly hours	26	47	79
30-40 Weekly hours	25	34	59
40+ Weekly hours	30	37	42
Total	860	**860**	**860**

RP
Pre COVID
55%
Didn't work from home

SP
For after COVID
46%
Say they will not work from home

RP June 2022
38%
not working from home at all today

More people combine remote working than excepted!

Work From Home – Dist.

All Set (~860 Participants)

Hours Working from Home	RP – Before Covid	RP - June2022	Diff (%)
Zero Hours	469	328	43%-
0-5 Weekly Hours	163	96	70%-
5-10 Weekly Hours	91	136	33%
10-20 Weekly Hours	56	120	53%
20-30 Weekly Hours	26	79	67%
30-40 Weekly Hours	25	59	58%
40+ Weekly Hours	30	42	29%

AVG = 5.6 Hours **AVG = 10.4 Hours**

85% Average increase of home working

Work Out of Home – Dist.

All Set (~860 Participants)

Workdays out of home a-week	RP – Before Covid	RP - June2022	Diff (%)
Zero Times	78	73	6%-
1 Time	30	63	110%
2 Times	36	85	136%
3 Times	58	107	84%
4 Times	66	127	92%
5 Times	503	324	36%-
6 Times	69	62	10%-
7 Times	20	17	15%-
	AVG = 4.2 Days	**AVG = 3.7 Days**	

13% Average decrease of workday out of home

- More participants combine remote working (regarding a 5-day workweek).
- Significant decrease among those who work 5 days at the office.

Work From Home – Dist.

All Set (~860 Participants)

Hours Working from Home	RP – Before Covid	RP - June2022	SP estimation April 2020	SP estimation June 2020
Zero Hours	469	328	393	402
0-5 Weekly Hours	163	96	151	137
5-10 Weekly Hours	91	136	112	126
10-20 Weekly Hours	56	120	81	77
20-30 Weekly Hours	26	79	46	47
30-40 Weekly Hours	25	59	36	34
40+ Weekly Hours	30	42	41	37

More participants combine home working than excepted (328 in RP, compared 393-402 in SP)

More participants Work from home part of the week than excepted (See Green comparison)

Some considerations in consider long-term impact

- The long-term effects of the pandemic on travel behavior are unknown
- In the Tel Aviv metropolitan area, the percentage of commuters in the peak morning hours is less than 25%
- Most of the increase is in shifting to telecommuting one or two days a week, which is an option only in some employment sectors
- Telecommuters tend to travel more for other purposes

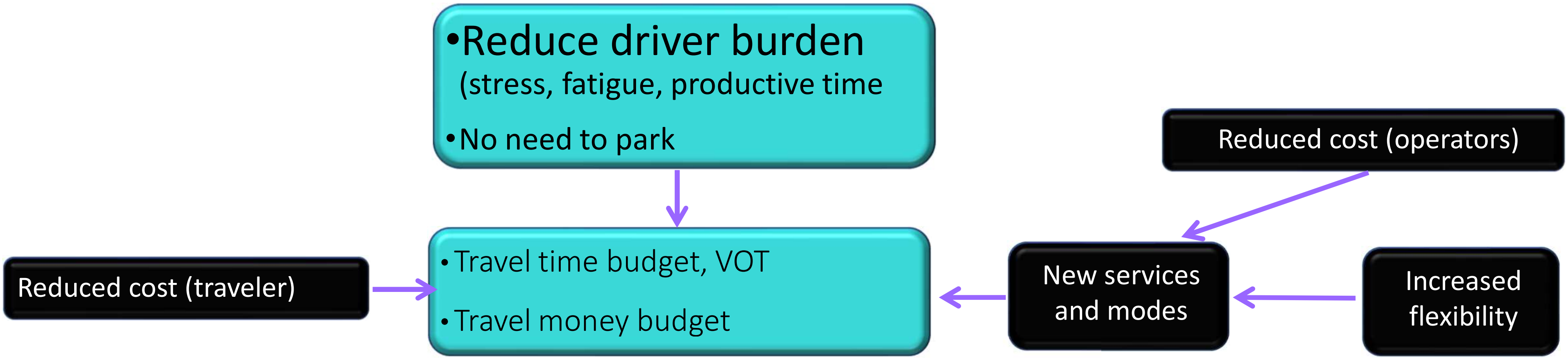
Connected and Automated Technology

- Electrification
- Automation
- Connectivity
- Mobility as a Service (MaaS)

For AV Behavior is a key to Impact

- **Can be a silver bullet – all will share…..**
- **Can result in hell – all will travel more…..**

- **Need to understand what policies/scenarios will move people from SOV**


•Reduce driver burden
(stress, fatigue, productive time
•No need to park
Reduced cost (operators)
Reduced cost (traveler)
• Travel time budget, VOT
• Travel money budget
New services and modes
Increased flexibility


Source: DHL Trend Research

Demand

- **Reduce driver burden**
  (stress, fatigue, productive time
- No need to park

Reduced cost (operators)

Reduced cost (traveler)

- Travel time budget, VOT
- Travel money budget

New services and modes

Increased flexibility

- Longer commute
- Travel distance to other purposes
- Changes in activity patterns
- More travel

- New opportunities
  - To all
  - To pop. who can't drive
- More options to accomplish tasks

Demand

- **Reduce driver burden** (stress, fatigue, productive time
- No need to park

Reduced cost (operators)

Reduced cost (traveler)

- Travel time budget, VOT
- Travel money budget

New services and modes

Increased flexibility

- Longer commute
- Travel distance to other purposes
- Changes in activity patterns
- More travel

- Residential location
- Land use
- City expansion
- Value of agglloremation

- New opportunities
  - To all
  - To pop. who can't drive
- More options to accomplish tasks

Impact on Behavior!!!

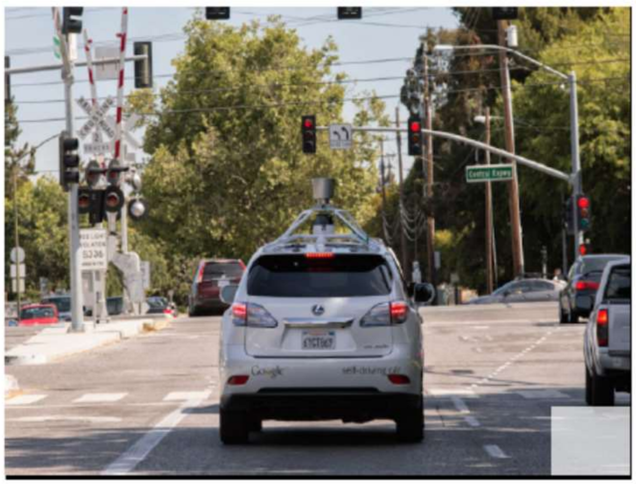
- *Ownership / Use*
- *Activity participation*
- *Destination Choice*
- *Mode Choice*
- *Land use/Residential Choice*
- *New car users*

Efficient Use of Travel Time

- How to adequately describe and measure **alternative time use**? (including productivity improvements or even the possibility of performing activities during the trip that are more enjoyable than driving)
- Extended time allocation models: impact on the **value of time**


The Driverless Car Debate: How Safe Are Autonomous Vehicles?

By **Lauren Keating**, Tech Times | July 28, 9:00 AM



As companies like Google and Delphi Automobile continue to test autonomous vehicles on the road, issues concerning the safety in regard to accidents and vulnerability in the software continue to rise. How safe are autonomous cars? (Photo : Google)

When it comes to the future of transportation, the first thing that comes to mind is the possibility of flying cars. It's easy to imagine an urban utopia with vehicles that float through the air, swerving around buildings, reaching toward the heavens.

While *Back to the Future: Part II* wrongly predicted that we would have this technology in 2015, autonomous vehicles—which are currently being tested—may just be the stepping stone to making this a reality. Who would've thought robot cars would be our present?

No matter what side you stand on in the safety debate, even those who have concerns still agree that this innovative technology is the way of the future.

Companies like Google, Delphi Automotive, Bosche, Tesla, Nissan Mercedes-Benz, Uber and Audi have already begun testing self-

Security Nightmare of Driverless Cars

TRIPWIRE GUEST AUTHORS (HTTP://WWW.TRIPWIRE.COM/STATE-OF-SECURITY/CONTRIBUTORS/GUEST-AUTHORS/)
OCT 25, 2015 | FEATURED ARTICLES (HTTP://WWW.TRIPWIRE.COM/STATE-OF-SECURITY/TOPICS/FEATURED/)
(HTTP://WWW.TRIPWIRE.COM/STATE-

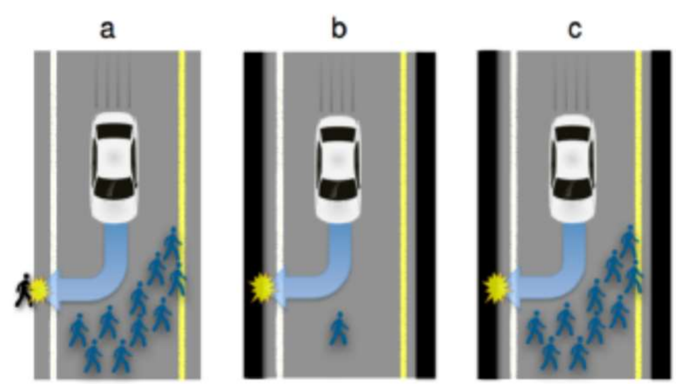
A View from **Emerging Technology from the arXiv**

Why Self-Driving Cars Must Be Programmed to Kill

Self-driving cars are already cruising the streets. But before they can become widespread, carmakers must solve an impossible ethical dilemma of algorithmic morality.

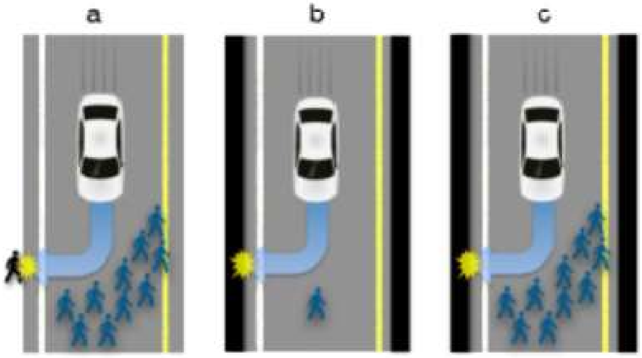
October 22, 2015

When it comes to automotive technology, self-driving cars are all the rage. Standard features on many ordinary cars include intelligent cruise control, parallel parking programs, and even automatic overtaking—features that allow you to sit back, albeit a little uneasily, and let a computer do the driving.



Factors Affecting Behavior

- *Ability to multitask*
- *Value of Time*
- *Safety perception*
- *Cyber security*
- *Ethics*
- *Cost*
- *Supply*
- *Policy*



Connected and Automated Technology

- The hype cycle around CAV
  - Reached its maximum expectations in 2015
  - For the full benefits we need all level 5, would we ever get there?
- Increased capacity vs. increased demand
  - The case of ride hailing services
  - The case of NY Subway
- The willingness to share- “the shared mobility lie” (Currie, 2018)
- Most recent studies exploring AV futures have found it essential to recognize a role for urban rail in carrying mass volumes of people as part of any scenarios where AVs help cities to work effectively (International Transport Forum 2015; NACTO – National Association of City Transportation Officials)

Implication for Infrastructure Investments

- Impact on future infrastructure planning and current infrastructure utilization, reducing the need to build new roads/rail systems?

- Higher capacity – but how much, not proved yet
- More and longer trips (in addition to increasing population and urbanization)
- The cheap and convenient emerging services
- Shared travel services – Low occupancy, extra VKT
- Require behavioral change even under optimistic technology scenarios

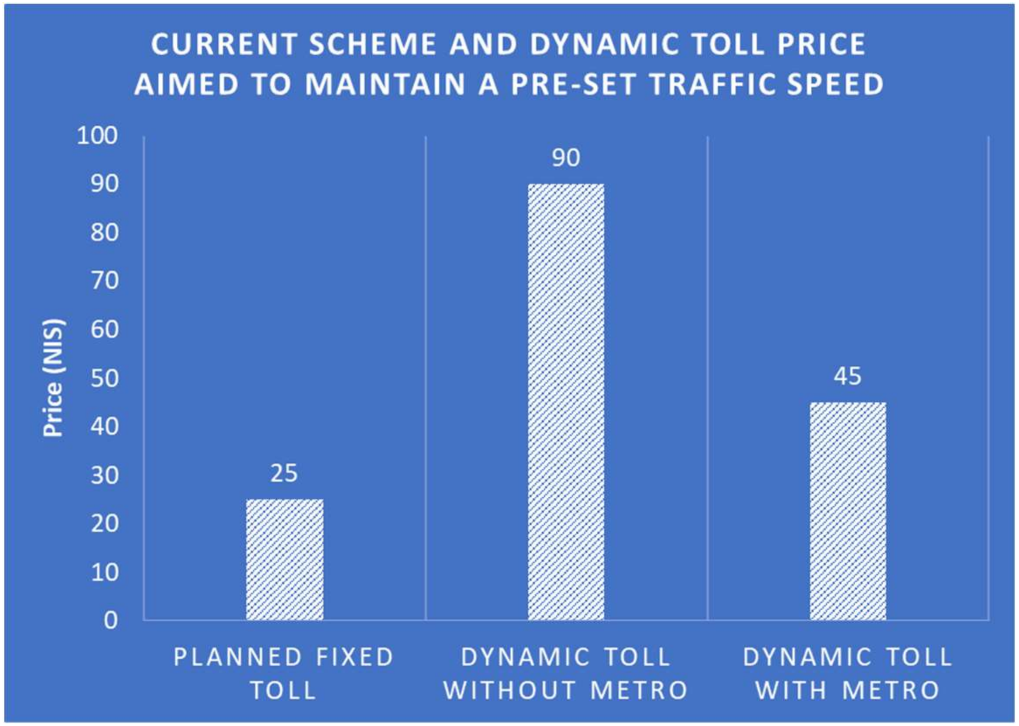
Re-thinking Transit Services - MAAS

- Mobility As A Service (MAAS)
- Transit services should be integrated with MAAS
- New mobility services should complement mass transit (last mile, access and egress, local trips)

Policy Implications

- Rethinking the current parking paradigm
- Policies to encourage sharing
- More intensive use of pricing policies
- Policies for limiting unnecessary travel by zero occupancy vehicles.
- Planners must consider taking actions today to prepare cities for driverless vehicles and sharing economy.

Congestion Pricing and the Metro



Added capacity to commercial centers

150 thousand

Travelers per hour

=

75

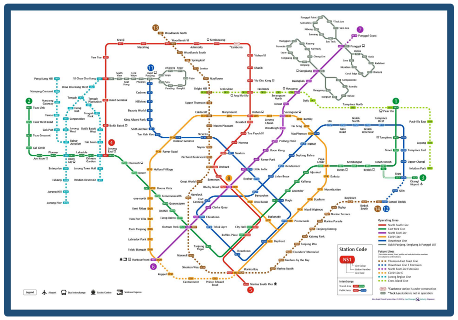
Fast lanes on the Ayalon highway

City	Starting year Congestion pricing	Total metro track length in Km	Additional metro lines being planned
Singapore	1975	200	6
London	2003	402	5
Stockholm	2007	106	4
Milan	2008	97	5

Congestion Pricing and the Metro

Singapore

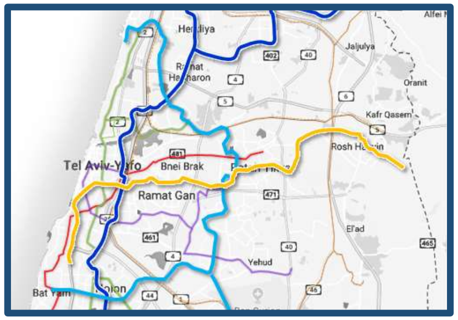
Population-5.8 million



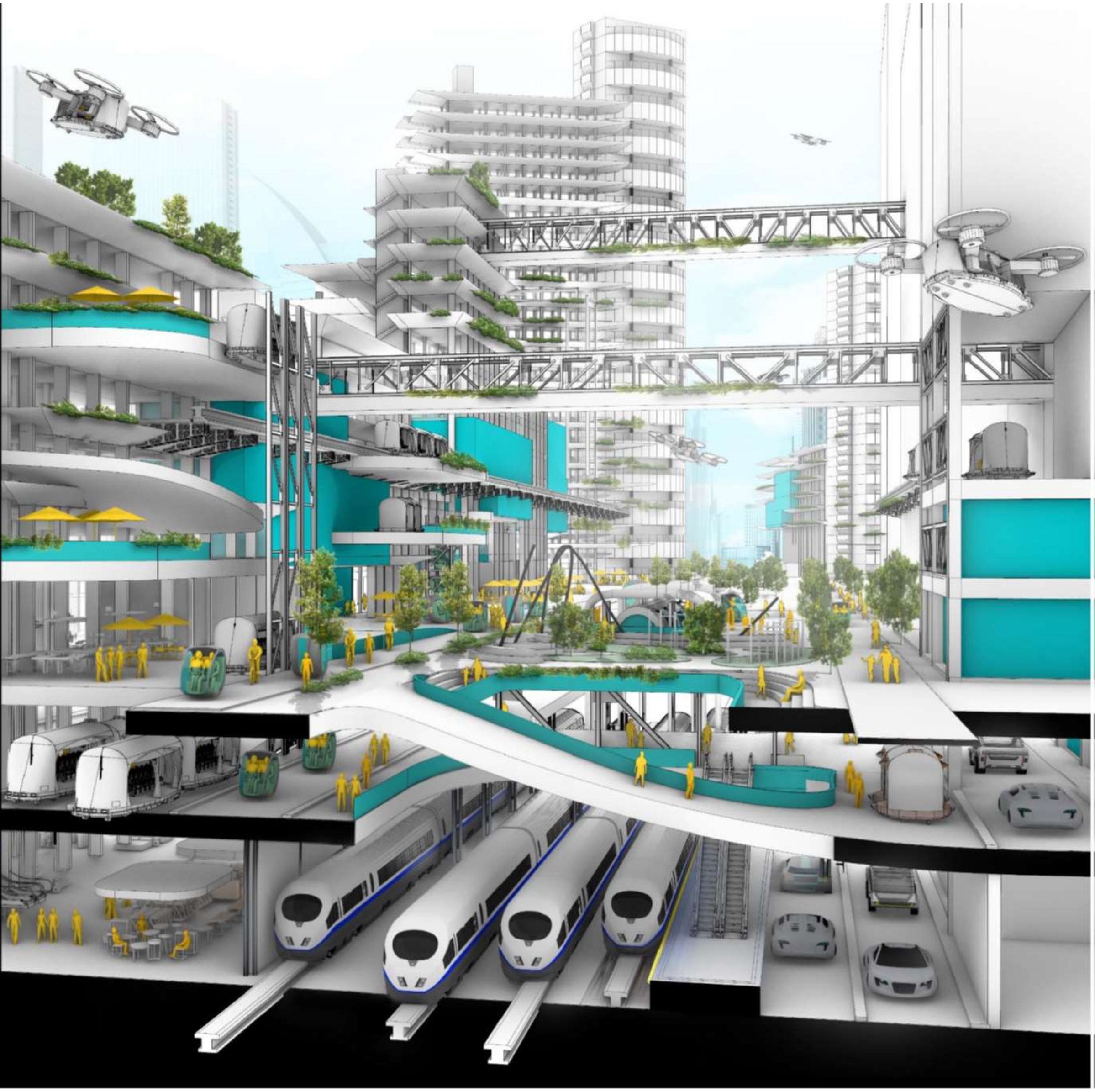
- Doubled its metro system in the past decade from 100 Km to 190 Km with an investment of 25 billion dollars
- Currently Planning 6 additional metro lines

Tel Aviv

Population- 5.4 million (Est. 2040)



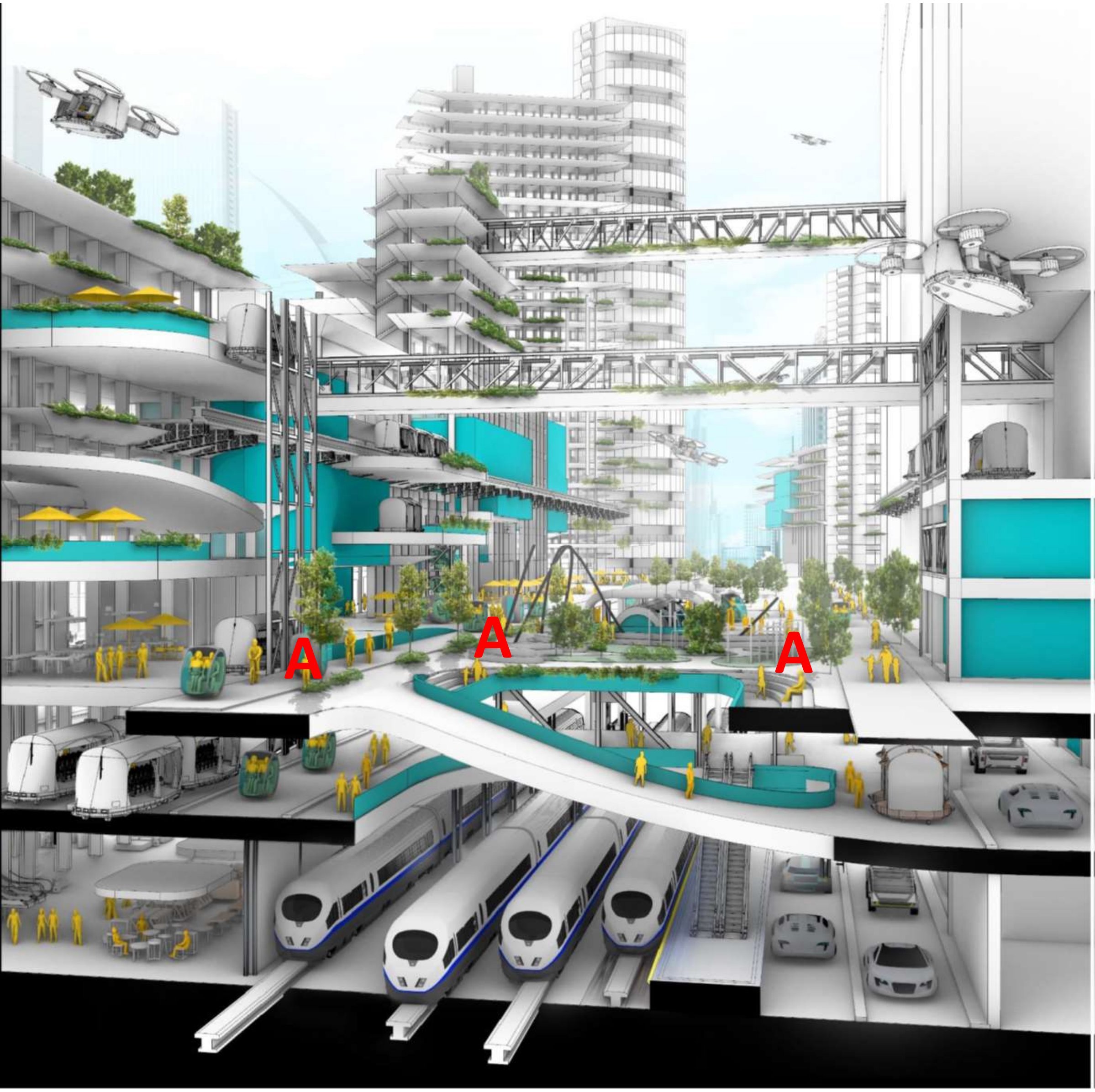
Metro investment: 40 billion dollars for 140 Km of metro lines



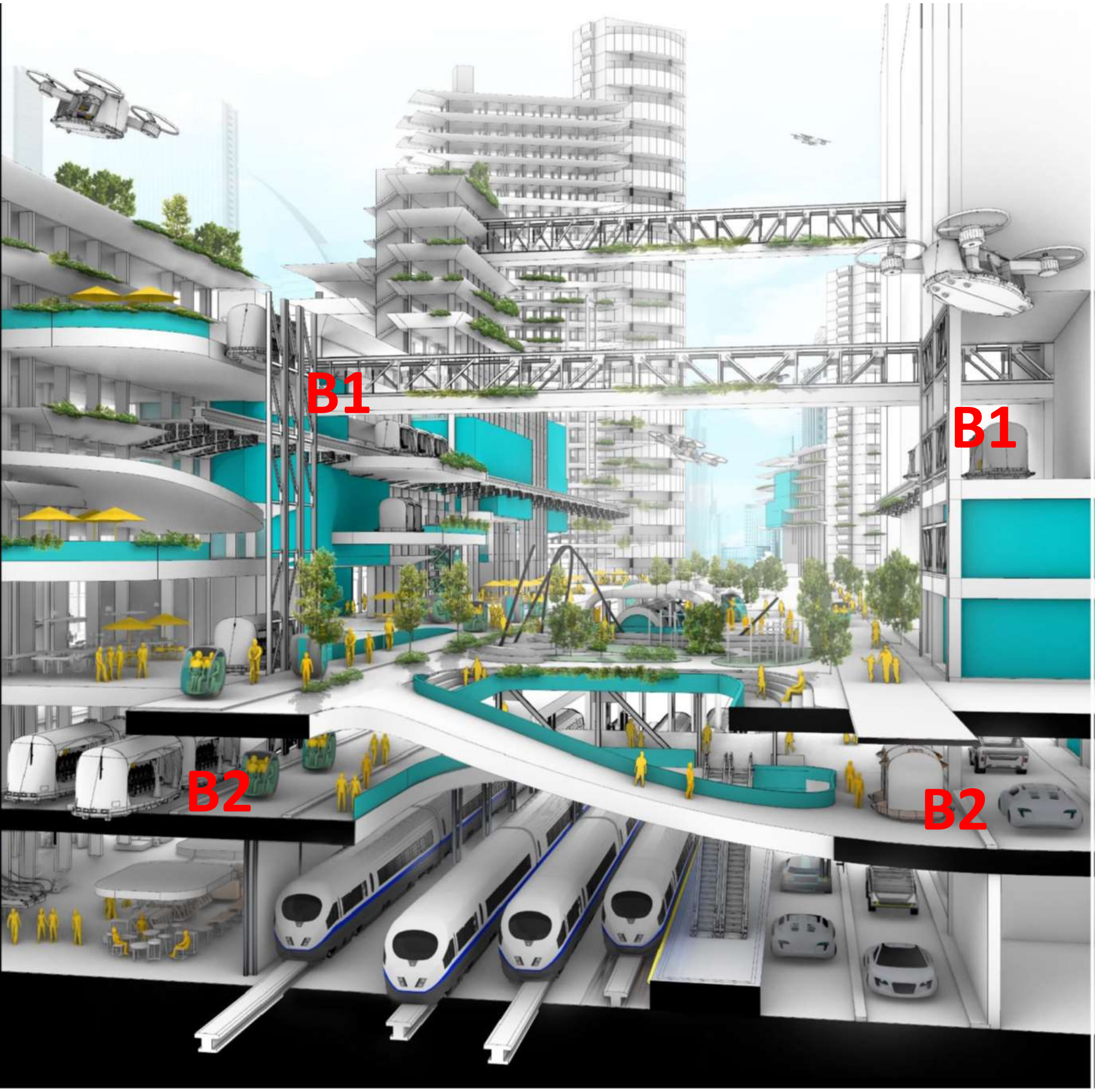
The City Landscape in 2100

The City Landscape in 2100

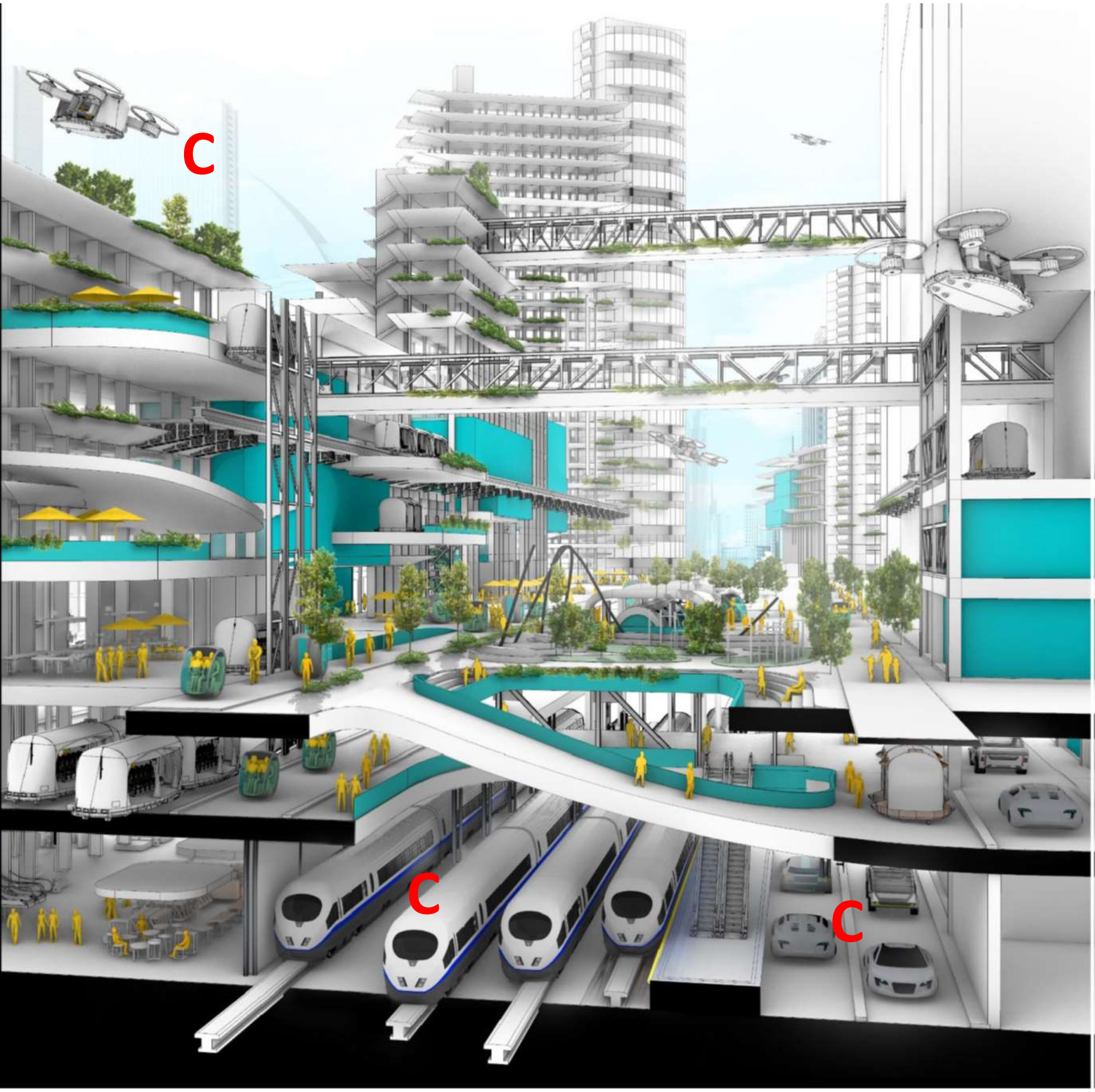
- Uses its technologies to enhance walkability between its intentionally diverse and mixed uses – **prioritizes people!!!**
- The **viability of pedestrian life is the focal point** from which all other considerations unfold
- The zoning does not divide it: quite the opposite. It focuses on a wide array of traffic modes and speeds and ensures connectivity between its different functions.
- The city depicts the future of an existing city, rather than a simulation of a new city built from scratch.
- The new technologies are interwoven into the existing building surfaces, street spaces, and transportation infrastructures of the city in a manner that respects the city form we know and cherish—major streets and boulevards that envelope buzzing commercial activities.



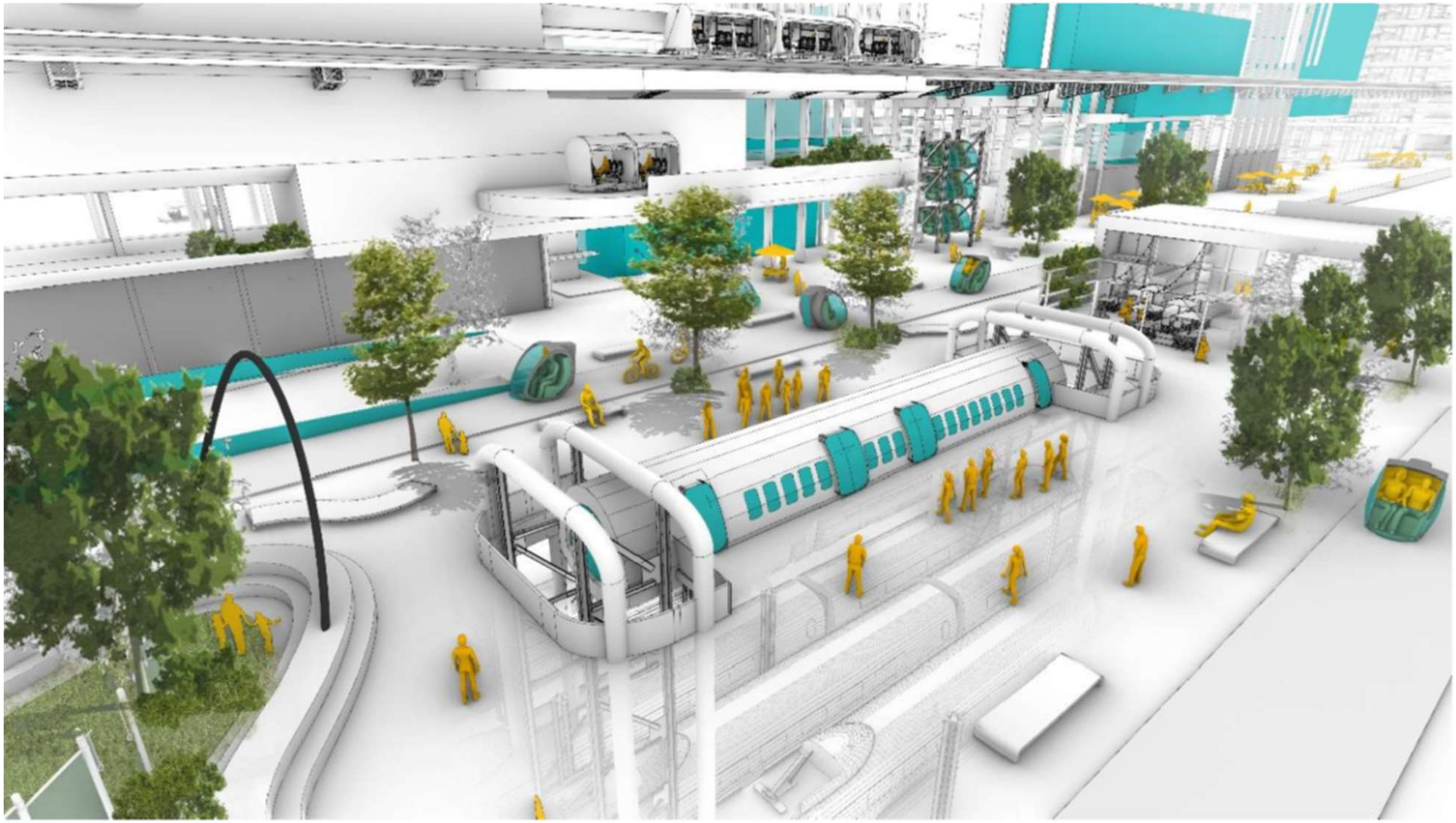
Zone A- main street prioritizes pedestrians
micro-mobility on dedicated lanes

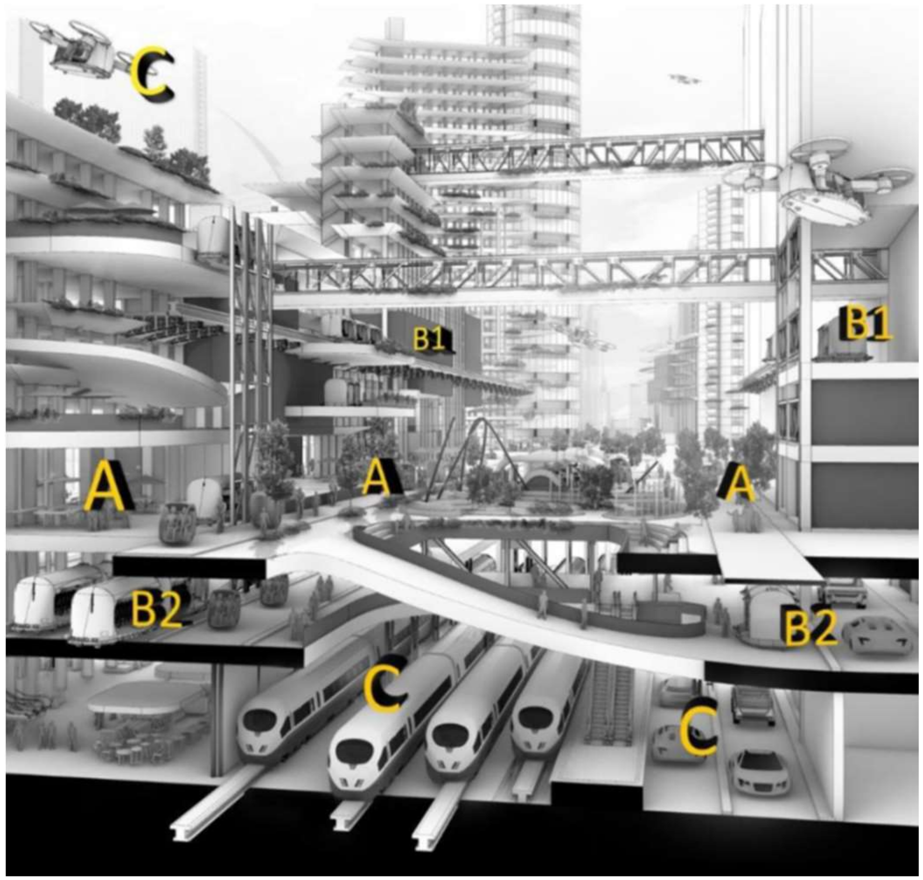


Zone B- Shared space
Zone B1 – slow public services, speed limit 20 MPH
Zone B2 – faster public transport, speed limit 40 MPH



Zone C- Fast lanes
Metro and underground toll highways
Urban air mobility

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Thank you!

Yoram Shiftan
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Financial Benefit 2040

Overall yearly benefit: 23-34 billion NIS

Overall construction costs: 154 billion NIS

Net Present value: 236-395 billion NIS

Benefit-cost ratio: 2.5-3.5

	Annual Benefit Billion NIS
Travel time saving	12.7
Goods travel time saving	2.5
Parking saving	1.4
Car maintenance saving	2.9
Car capital saving	0.7
Reliability	2.5
Economic development	8.4
Environmental	0.8
Car accident saving	0.4
Land use saving	1.1
Health	0.2
Public transport option value	0.1
Overall benefits	33.7

Cost

Discipline	units	Quantity	Price per Unit	Estimate (M)
Infra 1				**66,226**
Utilities relocation				3,708
Civil works (without stations)	km	138	183	25,174
Stations	Stations	106	360	37,344
Infra 2				**16,741**
Track	km	140	13	1,896
Systems	km	140	58	8,146
4 Depots				1,480
Rolling stock	Cars	932	5.6	5,219
Construction				**82,967**
Additional costs (13.5%)				11,201
Sub sum				**94,167**
Contingencies (40%)				37,667
Total with VAT				**154,246**

Item	Estimate (M)
Maintenance cost	**615**
Staff	242
Consumption	882
Operation cost	**1,124**
Renewal cost	**377**
Contingencies (20%)	423
Total	**2,539**
Total with VAT	2,971

Cost

- High technology cost (but decreasing over time).
- Decreased cost of crashes and insurance policies due to increased safety.
- Decreased operating costs, including parking cost and car-sharing vehicles.
- Decrease time cost
- Savings in parking space where land is scarce.
- Fuel and emission reduction

Emerging Services

- Reducing service operating costs by eliminating the need to pay drivers
- Increase flexibility by positioning vehicles to better respond to demand
- Encouragement of widespread use of vehicle and ride-sharing programs
- Engendering new modes that will be a cross between public and private modes available today

Issues in (Modeling) Adoption and use of Driverless Cars

Figure 9. Changes in ridership by mode, 2012 to 2013

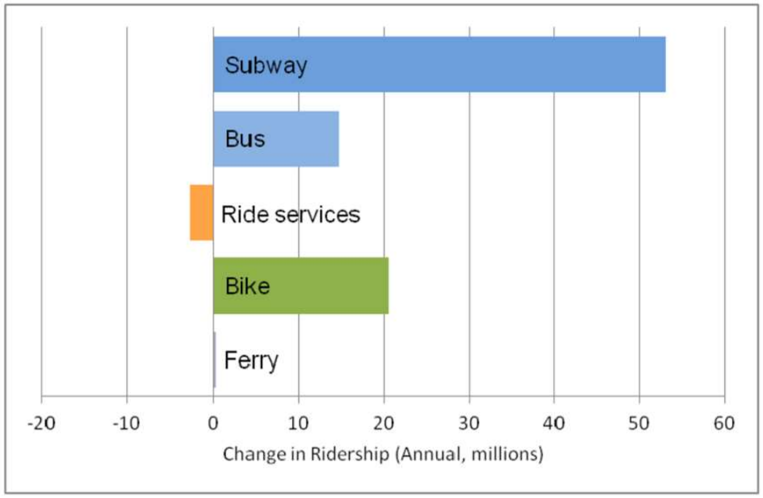


Figure 10. Changes in ridership by mode, 2013 to 2014

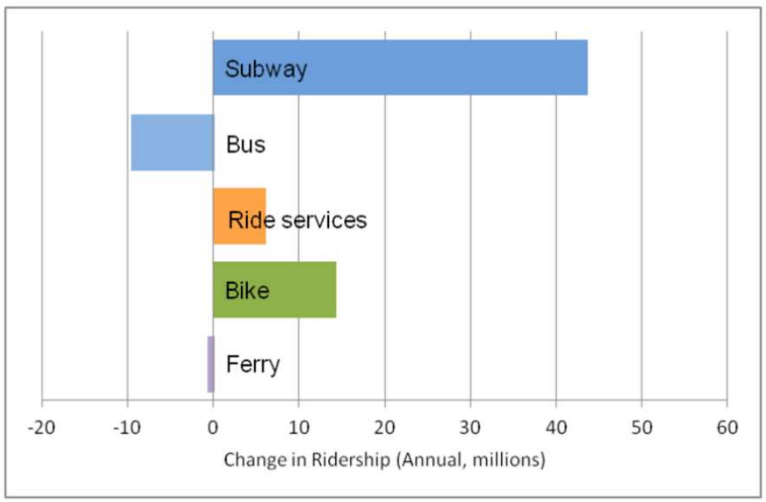


Figure 11. Changes in ridership by mode, 2014 to 2015

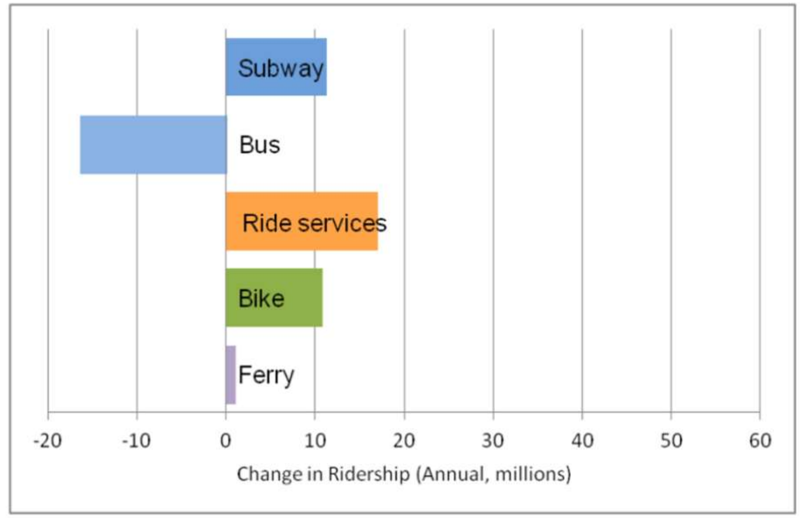
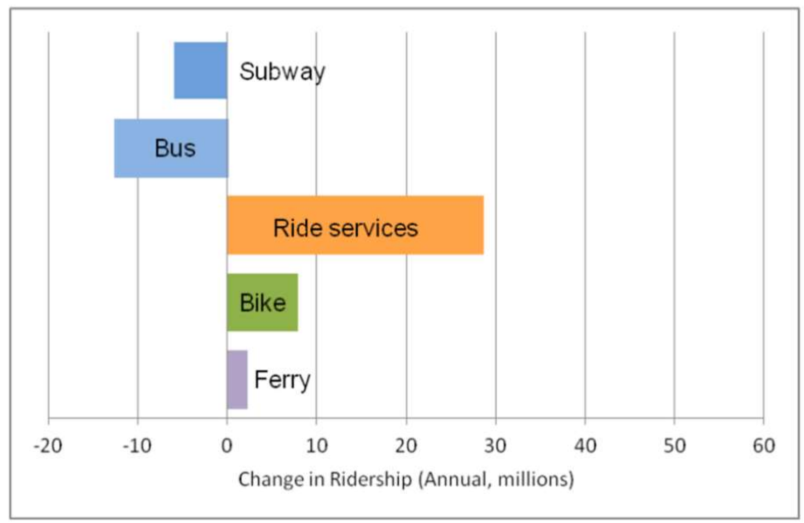
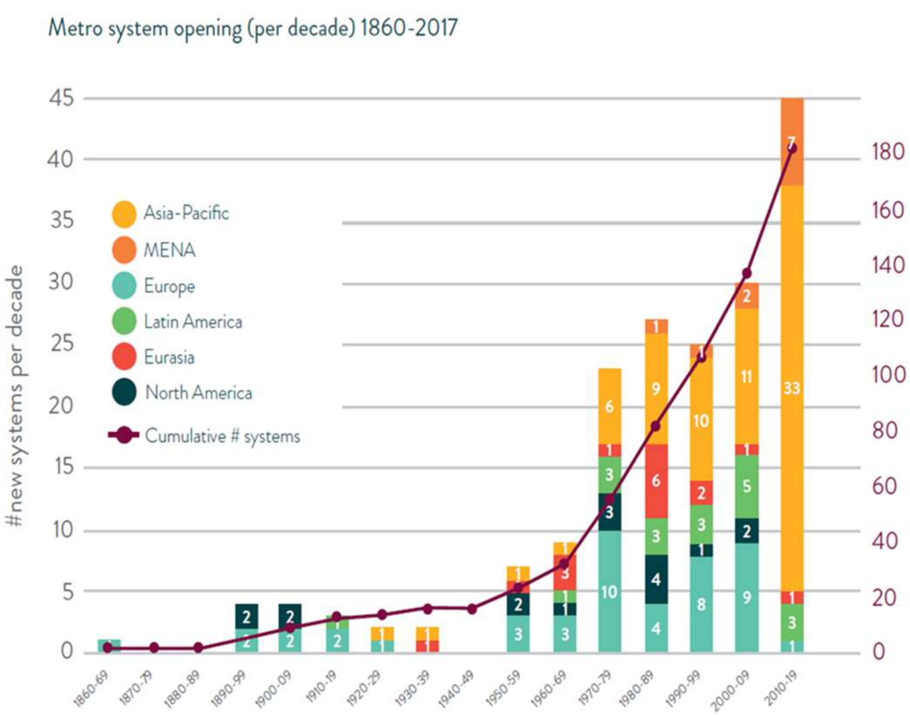


Figure 12. Changes in ridership by mode, 2015 to 2016



An old technology



- In Europe, 100 % of European urban areas between 3 and 6 million inhabitants encompass a MRT system ;
- In America, 70 % of American metropolitan areas between 3 and 6 million inhabitants encompass a MRT system
- Only large car designed areas from the United States of America do not have an MRT system.

Table 1: Tel Aviv in comparison to selected cities in Europe

City	Population (mil.)	No. of metro lines	% travel by PT (of motorized journeys)
London	8.3	11	47%
Madrid	6.5	13	41%
Berlin	3.4	10	46%
Barcelona	3.2	11	50%
Rome	2.9	3	30%
Lisbon	2.8	4	41%
Tel Aviv 2018	4	0	10%
Tel Aviv 2040	5.4	3	40%