37E00100 Information Economy

Digital transformation of transportation

Kari Koskinen, Niina Mallat

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Image by falco from Pixabay

Topics of the day

1. Introductions
2. Current trends and applications (Niina)
3. Analyzing the phenomena of autonomous vehicles
   - Technology (Kari)
   - Business models (Kari)
   - User adoption and trust (Niina)
   - Government and society (Niina)

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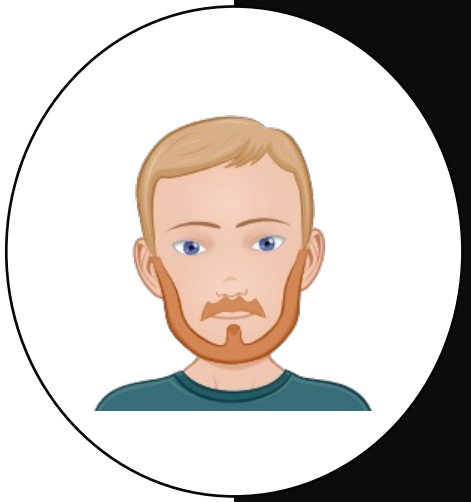
Introductions

Kari Koskinen, PhD Managem.

Postdoc Researcher, ISM dept.

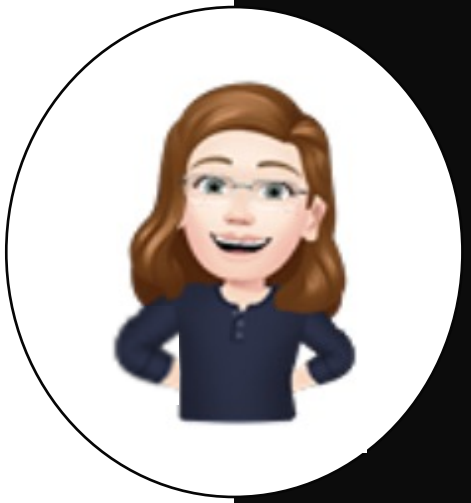
- Research focus areas: autonomous vehicles, digital innovation, digital ethics & sustainability, ICT4D



Niina Mallat, PhD Econ.

Research Fellow, ISM dept.

- Research focus areas: autonomous vehicles, business models, technology adoption and use



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1. Current trends and applications

Key trends in transportation

Trend	Expected benefits
Autonomous driving	• Safer roadways • Freed-up parking space, reduced number of cars • Productive commuting time
Connectivity	• Continuous data for vehicle R&D and over-the-air updates • Machine-machine and machine-infrastructure communication • Personalized infotainment services for passengers
Electrifi-cation	• Low emissions • Sustainable power sources, if batteries charged with clean energy and recycled efficiently
Shared mobility	• Accessible car rides • Adaptable vehicle designs -> more comfortable travel services • Potential reduction in the number of vehicles

Source: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-trends-transforming-mobilitys-future

Key trends: current examples

Shared and connected mobility

Autonomous vehicles

Electrification

34% of city buses in Helsinki are electric*

3% of all personal cars in Finland are fully electric**

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*Source: https://www.hsl.fi/hsl/sahkobussit **Source: https://www.aut.fi/en/statistics/vehicle_fleet/vehicle_fleet_by_fuel_type/passenger_cars

Digitalisation extending beyond the vehicle

- **Offering:** from a manufactured product to a digital and connected service
- **Business models:** from basic value chain to innovation ecosystems and service platforms
- **Customer purchase process**: from bricks and mortar to online
- **Infrastructure:** from road and traffic planning to smart cities and smart grids
- **Data:** from basic manufacturing, sales and road use data to connectivity, IoT and big data utilization
- …

Autonomous vehicle use cases – Land, Water, Air

Unmanned Ground Vehicles


Logistics


Logistics


People transport


Aerospace


Military


Mining


Agriculture, forestry

Unmanned Surface Vehicles

Cargo


Research, e.g. marine biology


Recreation

Unmanned Underwater Vehicles


Oil & gas


Research, e.g. sea floor


Search & rescue

Unmanned Aerial Vehicles (drones)


Photo, video


Military


Agriculture


Logistics


Search & Rescue


Maintenance & construction


Surveillance


Humanitarian

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2. Analyzing the phenomena:

Technology

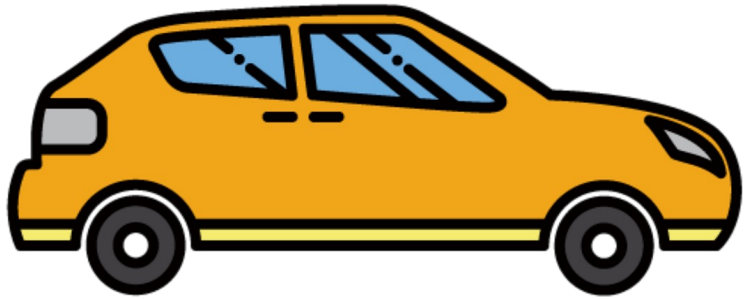
Technology

Examples of digital systems & solutions in a passenger car

Lane departure warning
Blind spot monitor
Cross traffic alert
...

Airbag deployment system
Rain sensing sweepers
....

Traction control
Anti-lock braking
Active suspension mgt
Vehicle stability
Hill-holder
Tire pressure monitors
Parking assist/automatic parking
Remote assist
...



Autonomic Cruice Control
Collision avoidance
Adaptive lights
...

Communication
Infotainment
Summon
Automatic climate control
Navigation
Driver monitoring
Driver seat configuration
...

Engine management
Emission management
Continuously variable transmission
...

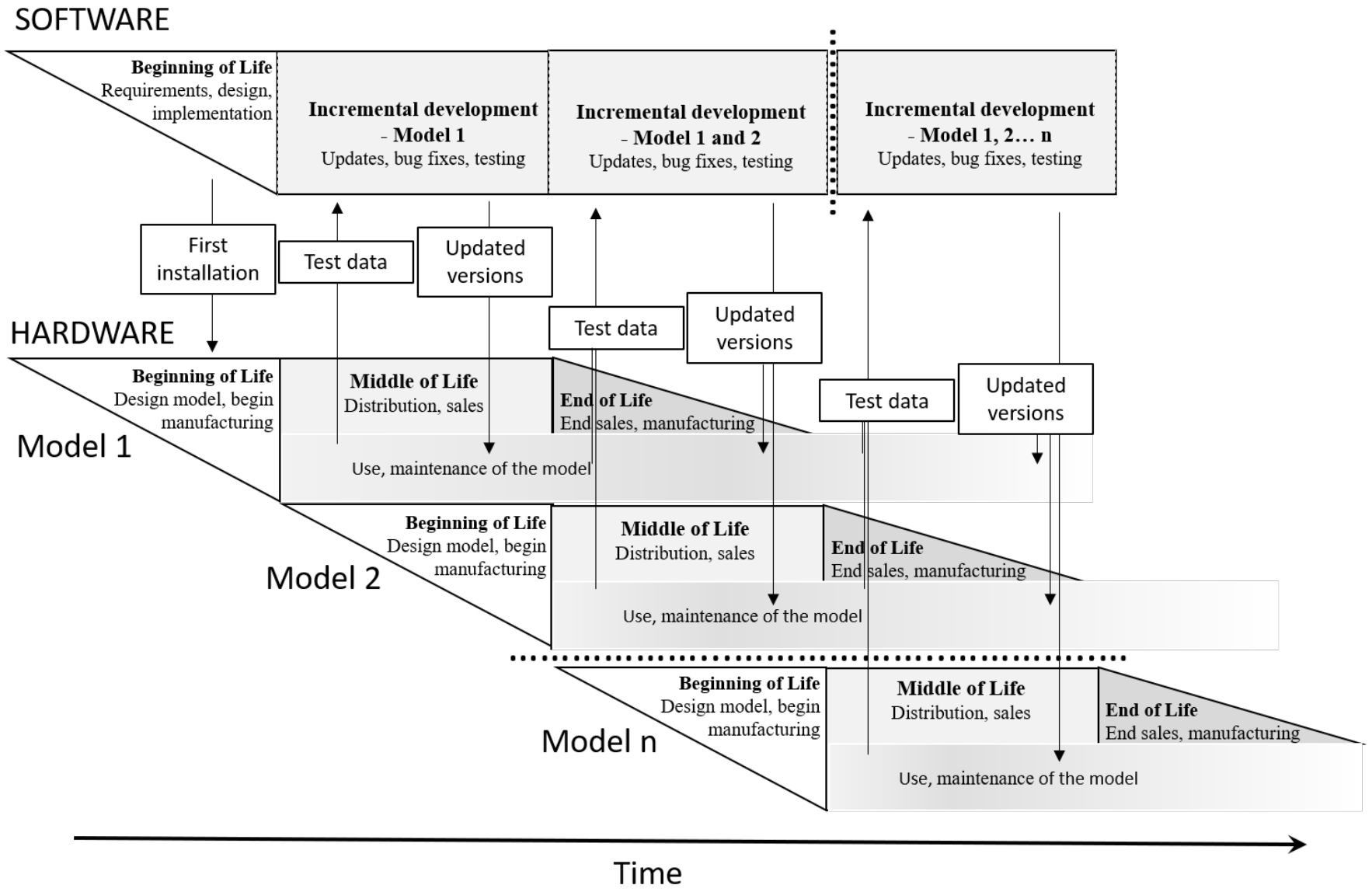
Image by 政徳 吉田 from Pixabay

Digital transformation of vehicles

- Increasing amounts of digitally controlled components & functionalities incorporated into the vehicle design
    - Innovation via bundling:
      interconnected functions instead of isolated systems
- Digitised components controlled by algorithms enable higher levels of automation of various aspects of vehicles
- Combined with connectivity:
    - Transmit data of vehicle use and operations e.g. for the purposes of product development
    - Facilitate frequent change via over-the-air (OTA) software updates

Photo by Jonas Leupe on Unsplash

Vehicle development – separation of HW and SW



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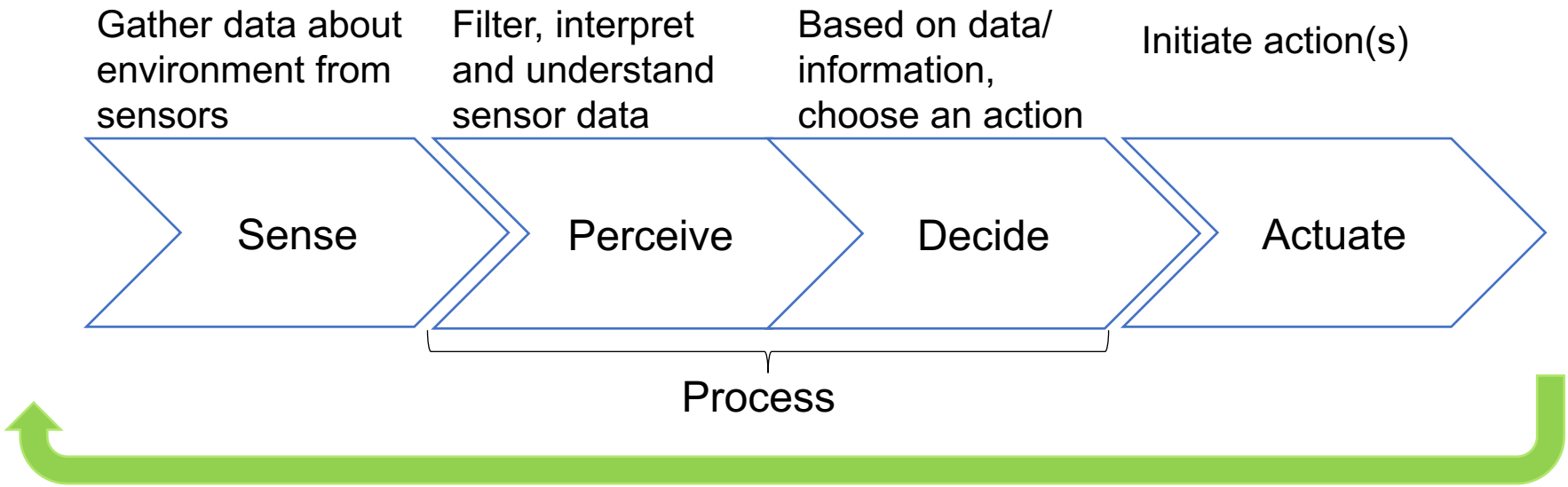
Autonomous driving technology

Autonomous vehicles (AVs): sense-process-actuate loop



	SAE LEVEL 0™	SAE LEVEL 1™	SAE LEVEL 2™	SAE LEVEL 3™	SAE LEVEL 4™	SAE LEVEL 5™
What does the human in the driver's seat have to do?	**You <u>are</u> driving** whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering			**You <u>are not</u> driving** when these automated driving features are engaged – even if you are seated in "the driver's seat"		
	You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			When the feature requests, you must drive	These automated driving features will not require you to take over driving	
	These are driver support features			**These are automated driving features**		
What do these features do?	These features are limited to providing warnings and momentary assistance	These features provide steering **OR** brake/ acceleration support to the driver	These features provide steering **AND** brake/ acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met		This feature can drive the vehicle under all conditions
Example Features	• automatic emergency braking • blind spot warning • lane departure warning	• lane centering **OR** • adaptive cruise control	• lane centering **AND** • adaptive cruise control at the same time	• traffic jam chauffeur	• local driverless taxi • pedals/ steering wheel may or may not be installed	• same as level 4, but feature can drive everywhere in all conditions

A?

Source: sae.org

Current status of autonomous vehicles

- Most systems somewhere at level 2-3
  - Examples of 4 exist
  - AI (and data) plays a bigger role, more computational power required
- Challenge of operating in all scenarios and situations
  - For instance, AV systems have had challenges with tunnels, bridges, signs over the road, recognizing static obstacles, predicting movements.
- Operational Design Domains (ODD): The specific conditions in which a system is intended to function
  - Limitations based e.g. on location, road types, speed, time of day, weather
  - Change the environment to facilitate autonomous driving?

Mercedes-Benz DRIVE PILOT becomes first Level 3 autonomous driving system to be certified for US roads

Scooter Doll | Jan 26 2023 - 12:34 pm PT | 69 Comments

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2. Analyzing the phenomena:

Business models

Implications of vehicle digitalization to business models

- In very simple terms, business model answers what is being offered and how
- Changes in value propositions due to introduction of new technologies
- Digitalization of not just the product but processes around those
    - Implications to OEMs, car dealers, component producers etc.
    - New services created
    - Emergence of new businesses

TECH / TRANSPO / CARS

BMW starts selling heated seat subscriptions for $18 a month / The auto industry is racing towards a future full of microtransactions

By JAMES VINCENT
Jul 12, 2022, 1:45 PM GMT+3 | 0 Comments / 0 New

BMW / CARS / TRANSPO

BMW drops plan to charge a monthly fee for heated seats

Photo by Abigail Bassett for The Verge

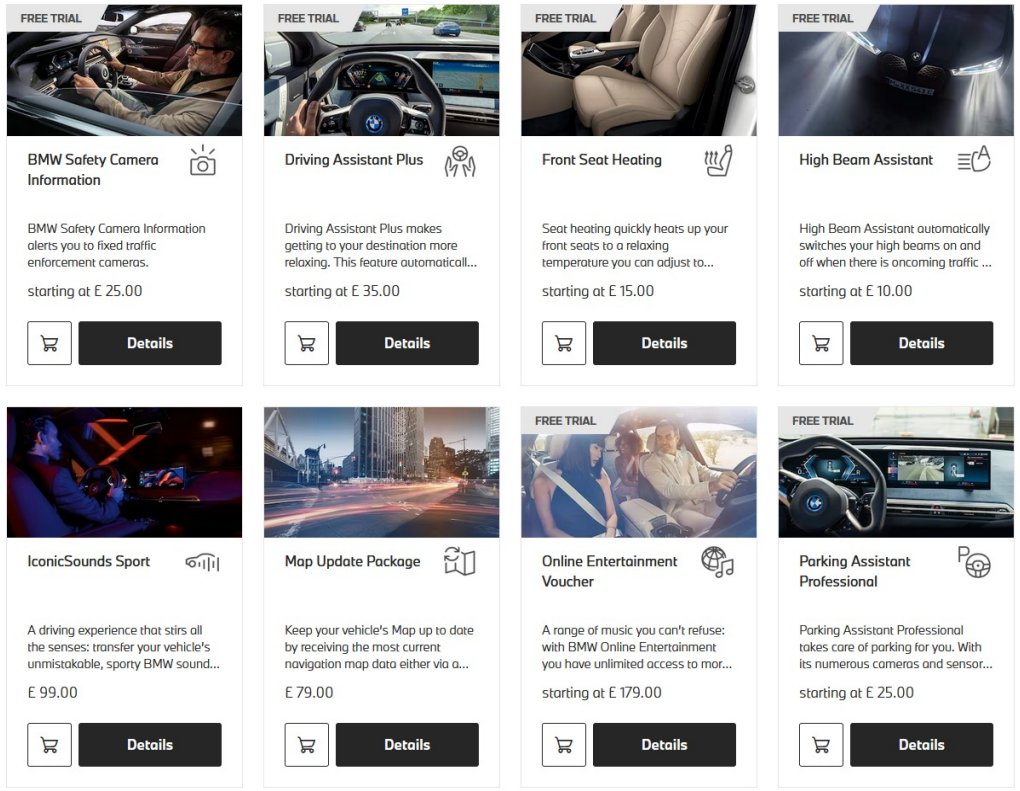
/ Customers can now toast their tushies without paying a monthly subscription after the German automaker removed it from its digital store of added features.

By Andrew J. Hawkins, transportation editor with 10+ years of experience who covers EVs, public transportation, and aviation. His work has appeared in The New York Daily News and City & State.
Sep 7, 2023, 9:38 PM GMT+3

126 Comments (126 New)

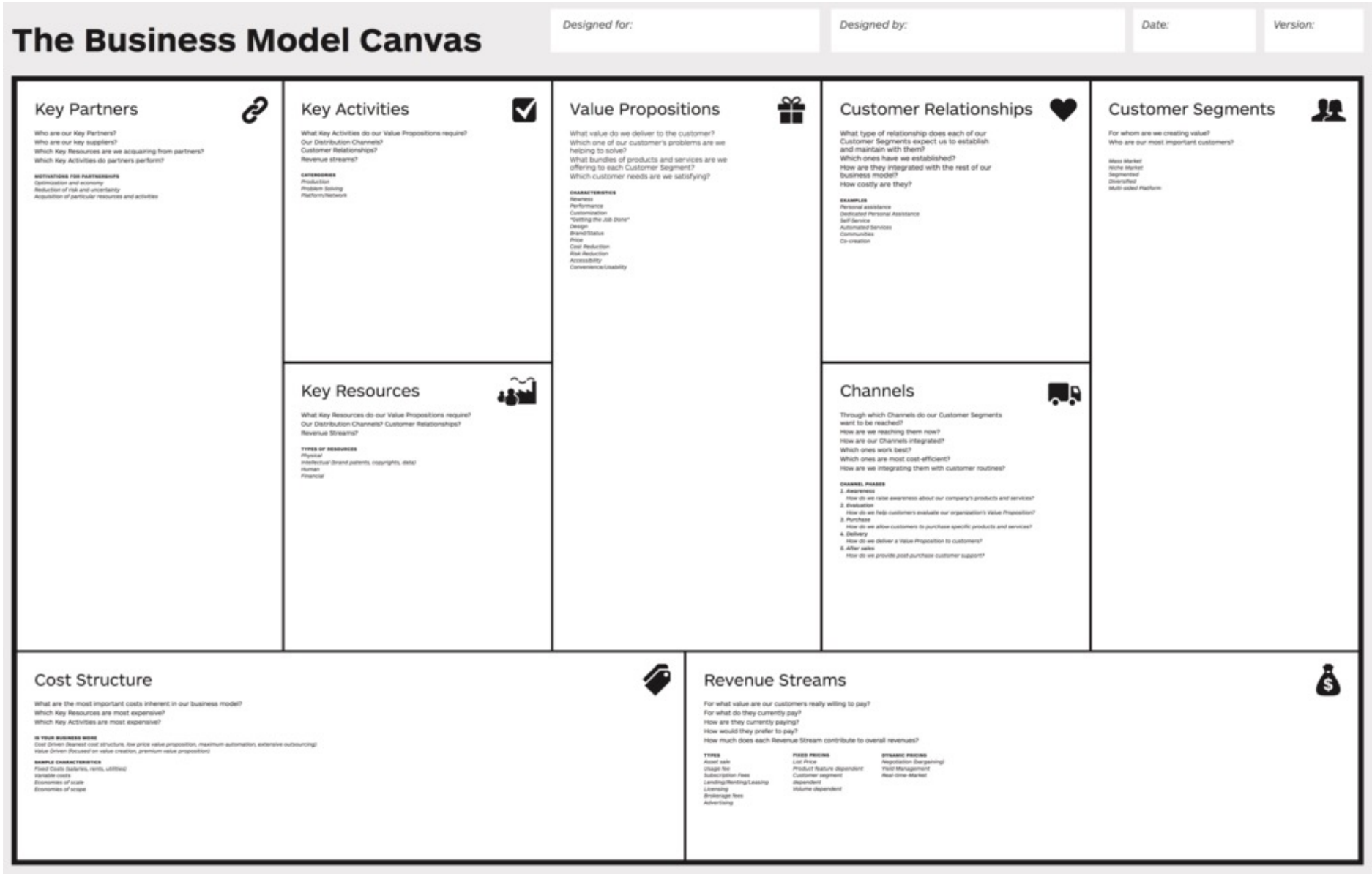
Implications of AVs to business models

- Examples
  - Implications for taxi companies if a SAE level 5 vehicle is developed?
  - Services an OEM offers or could offer?
  - Focus on a particular component instead of the whole vehicle (or other way around)?
  - Car as a platform?
- A change in business model entails changes, for example, in pricing models, marketing, key customers and stakeholders, cost structures, internal processes



https://www.bmw.co.uk/en/shop/ls/cp/connected-drive

Tools & Frameworks – Business Model Canvas



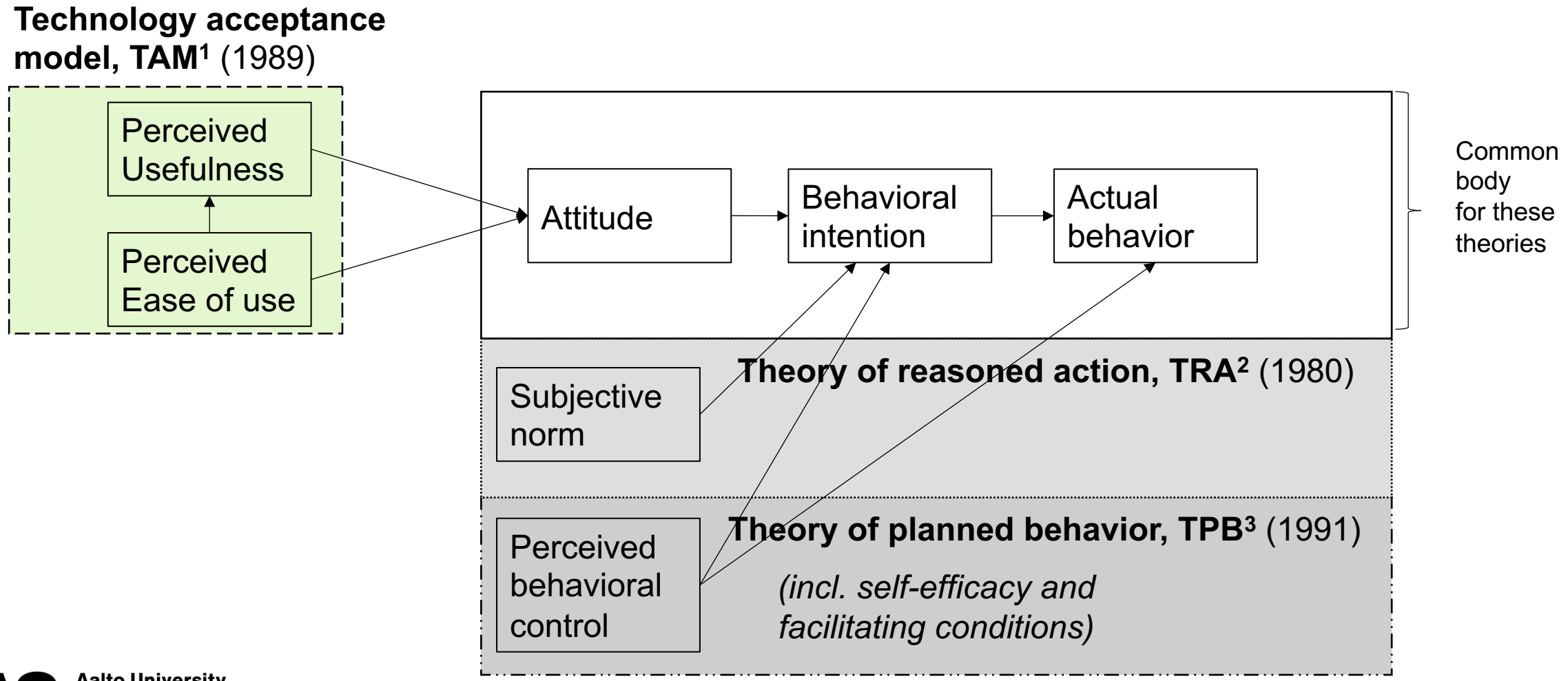
A?

https://en.wikipedia.org/wiki/Business_Model_Canvas

2. Analyzing the phenomena:

User adoption and trust

Tools and frameworks - classic theories on IS adoption and use



1) Davis, F.D., 1989. Perceived usefulness, perceived ease of use and user acceptance of information technology. MIS Quarterly, 13(3): 319–340.
2) Ajzen, I. & M. Fishbein, Understanding Attitudes and Predicting Social Behavior, Prentice Hall, Englewood Cliffs, NJ, 1980.
3) Ajzen, Icek (1991). "The theory of planned behavior". *Organizational Behavior and Human Decision Processes*. 50(2): 179–211.

Tools and frameworks - Diffusion of Innovations[1]

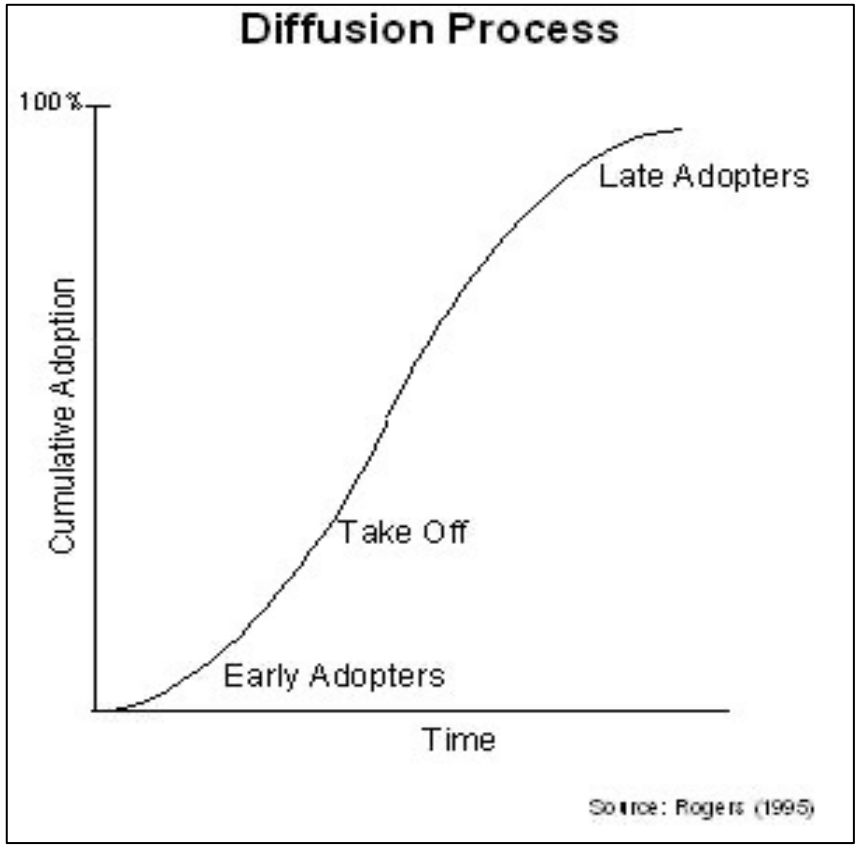
Innovation characteristics

- **Relative advantage:** superiority to existing solutions
- **Compatibility:** consistency with values, experiences and needs
- **Complexity:** difficult to understand and use
- **Trialability:** ease of testing
- **Observability:** visibility to others

Adopter characteristics

- **Innovators 2.5%**
- **Early adopters 13.5%**
- **Early majority 34%**
- **Late majority 34%**
- **Laggards 16%**

In general, earlier adopters have:
- higher education
- higher social status
- more favorable attitude towards change
- more tolerance to uncertainty and risk
- larger networks (personal & media use)
- greater knowledge of innovations
- higher degree of opinion leadership



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[1]Rogers, Everett M. (1962). Diffusion of Innovations. The Free Press. New York and the most recent: Rogers, Everett M. Diffusion of Innovations. 5thed. New York: Free Press, 2003.
See also: https://en.wikipedia.org/wiki/Diffusion_of_innovations

Application: factors affecting robot bus use

Theory	Variable	Factor
TAM	Usefulness	• Reduced travel time • Reduced waiting times • Suitable or customized routes • Good overall accessibility • Price
	Ease of use	• Ease of access (routes, stops, schedules, even ordering) • Ease of purchasing the tickets • Ease of boarding the bus (e.g., for the special groups)
TRA	Subjective norm	• Reputation gained and appreciation by important others
TBP	Perceived behavioral control	• Familiarity with robot buses • Ability to use robot buses
Diffusion of innovations	Compatibility & Adopter characteristics	• Multimodal travel patterns (frequent use of different travel modes, e.g.; car, public transport, bicycle) • Personal innovativeness

Other factors: environmental friendliness, impact in employment, preference to exert control and make own driving decisions (good to note: the adoption theories do not explain everything)

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Based on literature research conducted by lecturers; 12 scientific articles studying users of robot bus pilots / shared driving

Trust and safety concerns also among important factors affecting robot bus use

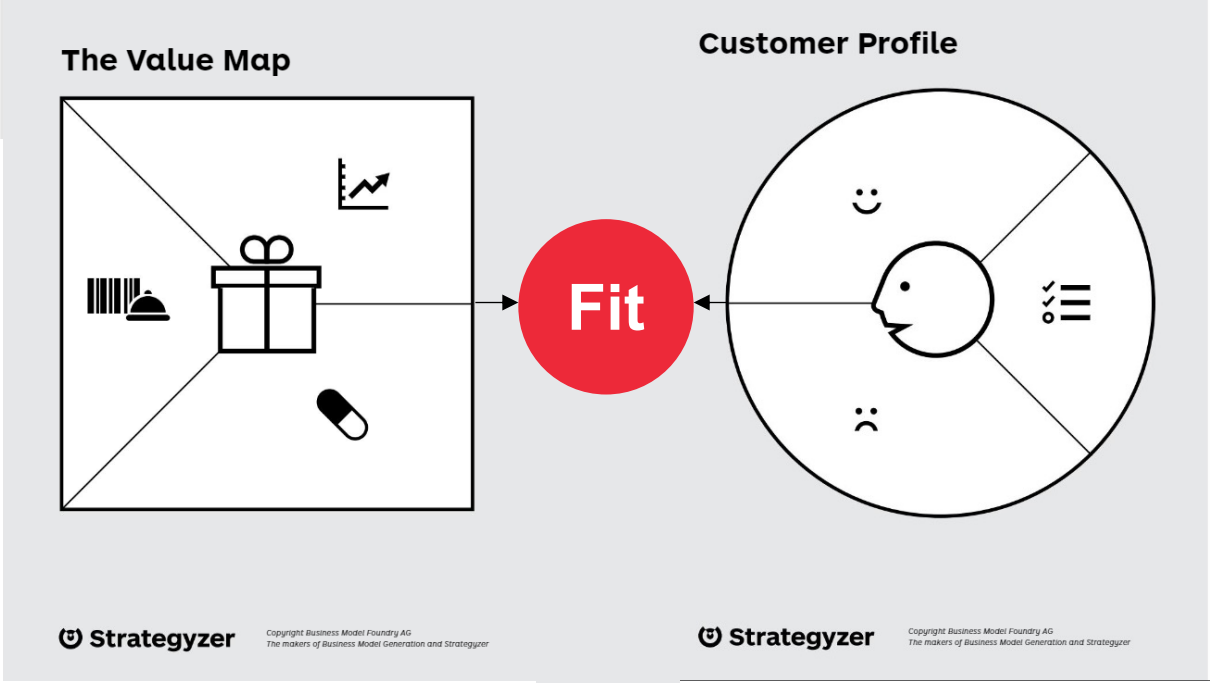
- **Trust**: Perceived reliability, trustworthiness, overall safety of the robot bus
- **Safety concerns**:
  - **Traffic safety**: frequency and severity of traffic accidents for robot buses
  - **In-vehicle safety**: anti-social behavior in the robot bus
  - **Emergency management**: processes during e.g., fire, jammed doors, …
  - A **transit employee** on board often seen as important
  - Humans seen as more capable in overcoming sudden situations, rectifying errors and improvising
  - Robot buses seen as able to remove human errors and detect obstacles better
  - Overall, accidents caused by humans deemed as more acceptable than by automation
- **Privacy**: vulnerability to hacking, protection of user-related data

Based on literature research conducted by lecturers; 12 scientific articles studying users of robot bus pilots/ shared driving

Tools and frameworks – Value Proposition Design

The Value Proposition Design book[1] is a practical tool from the authors of Business Model Canvas, designed for business audiences. It covers the value proposition and customer segment parts of the canvas in detail.

The Value Map describes a specific value proposition in your business model in a more structured and detailed way. It breaks your value proposition down into **products and services**, **gain creators** and **pain relievers**.



Customer Profile describes a specific customer segment in your business model in a more structured and detailed way. It breaks the customer down into **jobs, gains** and **pains**.

You achieve **Fit** when your value map meets your customer profile – i.e., produces pain relievers and gain creators for your customer

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[1]Osterwalder et al. 2014: https://www.strategyzer.com/books/value-proposition-design

Application of the Value Proposition Design - example

Think about the transportation related jobs, pains and gains of the different user ‘personas’, and what can different solutions offer to them?

Examples of transport user ‘personas’:

- **Private car user**: A mom of three, living in a suburban area, owns a car
- **Public transport user**: A young single adult, living in a city, has a driver's license, does not own a car

Current use

- Personal car
- Taxi
- Car sharing
- Public transportation
- Robot bus pilots

Future innovations

- Autonomous vehicles (private)
- Autonomous taxis
- Mobility-as-a-service
- Autonomous public transport

2. Analyzing the phenomena:

Government and society

Role of government

The role of government and public institutions in enabling new innovations

- Infrastructure:
  - Build and maintain infrastructure in a manner that supports innovation
- Regulation:
  - Create enabling yet secure/stable regulatory frameworks, taxation
  - State/national/international
- Innovation support:
  - Funding, initiatives, resources, ecosystems

- Creating and developing innovations itself?

Thank you!

Questions?