

Management Information Systems (37C00100)
Department of Information and Service Management
Aalto University School of Business, Espoo Finland
March 21st, 2024

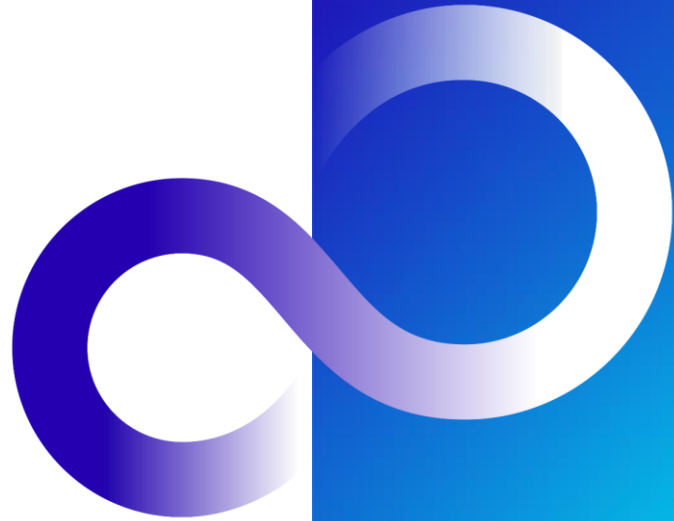
Beyond ERP – digital innovation driving sustainability transformation

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Fujitsu overview



Headquarters
Tokyo, Japan

Established
1935

Principal business areas
Service Solutions
Hardware Solutions
Ubiquitous Solutions
Device Solutions

World's fastest computing technology
(Fugaku, No.1 in HPCG and Graph500)

#6 in the world in terms of the number of
AI-related patent applications (WIPO)

Employees*
124,000 worldwide

Revenue**
22.8 billion euro

Operating profit**
2.1 billion euro

R&D expenses**
671 million euro
(Approx. 3.0% of revenue)

Stock exchange listing
Tokyo (Code 6702)
Nagoya

* Number of employees: As of end of March 2023

** Consolidated financial figures for fiscal year ending March 31, 2023

Fujitsu in Finland

Over 60 years of
Finnish ICT history

Approx. 1700 employees*
351 million euro revenue**

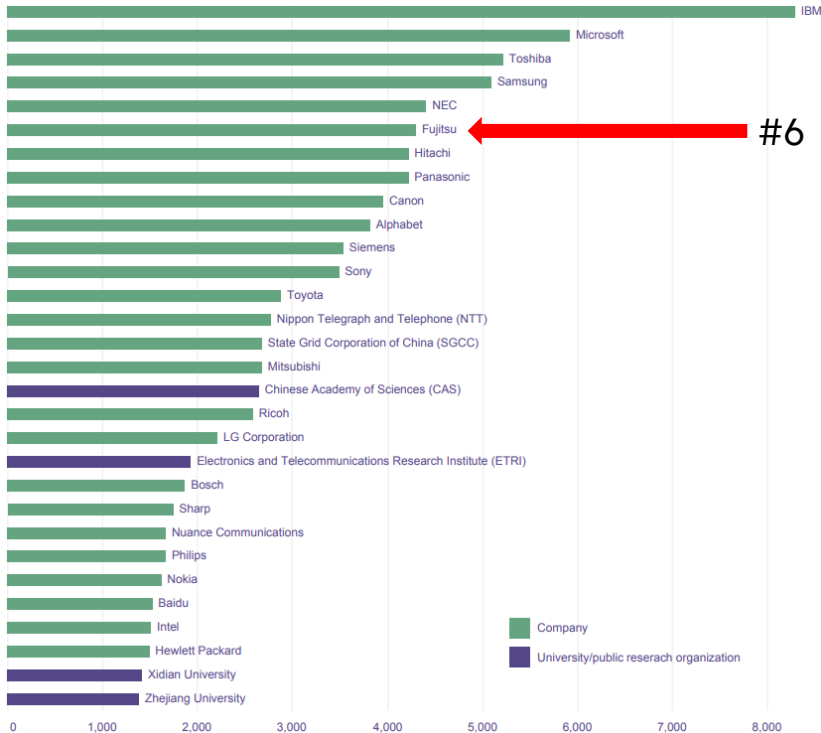
300 customers in private
and public sector

Carbon neutral since 2021

Leadership 58% women

Consultation, Professional Services,
Business Applications, Digital
Workplace, Cloud Services, Hybrid IT,
Managed Services, Cybersecurity

Top 30 AI patent applicants by no of patent families (2019)



Fujitsu's patent portfolio by AI application field (2019):

Transportation	333
Personal devices, computing and HCI	709
Telecommunications	593
Document management and publishing	521
Life and medical sciences	119
Security	206
Business	463
Industry and manufacturing	61
Physical sciences and engineering	53
Energy management	18
Arts and humanities	163
Networks	241
Education	67
Cartography	361
Entertainment	55
Computing in government	38

Fujitsu's patent portfolio by AI functional application (2019):

Computer vision	2727
Speech processing	608
Natural language processing	640
Control methods	105
Knowledge representation and reasoning	176
Robotics	56
Planning and scheduling	46
Predictive analytics	35
Distributed AI	10

Evaluation of actions: sustainability matrix



Contribution to Sustainability	Sustainability in Consumer Experience			Business Impact of Sustainability					Total
	Consumption Choices	Social Consumption	Sustainability in Consumer Experience	Sustainable Production	Resource Management	Carbon & Climate Action	Business Impact of Sustainability		
	Informing choice, communication actions 0/1 (no or very little contribution) 3 (use-cases that support the theme) 5 (use-cases targeted to the theme)	Enable consumption as experience 0/1 (no or very little contribution) 3 (use-cases that support the theme) 5 (use-cases targeted to the theme)	Total 0/1 (no or very little contribution) 3 (use-cases that support the theme) 5 (use-cases targeted to the theme)	Total 0/1 (no or very little contribution) 3 (use-cases that support the theme) 5 (use-cases targeted to the theme)	Total 0/1 (no or very little contribution) 3 (use-cases that support the theme) 5 (use-cases targeted to the theme)	Total 0/1 (no or very little contribution) 3 (use-cases that support the theme) 5 (use-cases targeted to the theme)	Total 0/1 (no or very little contribution) 3 (use-cases that support the theme) 5 (use-cases targeted to the theme)	Total 1 (no contribution) - 5 (aligns well)	
Sustainable Experience									
Commerce platform	● 5,0	● 3,0	● 4,0	○ 1,0	○ 1,0	○ 0,0	○ 0,7	2,3	
Store commerce	● 3,0	○ 0,0	○ 1,5	○ 1,0	○ 1,0	○ 0,0	○ 0,7	1,1	
Microstore network	○ 0,0	○ 0,0	○ 0,0	○ 0,0	○ 0,0	○ 1,0	○ 0,3	0,2	
Last mile delivery and fulfillment	○ 0,0	○ 0,0	○ 0,0	○ 0,0	○ 0,0	● 3,0	○ 1,0	0,5	
Recommerce	● 5,0	● 5,0	● 5,0	○ 1,0	● 5,0	● 3,0	● 3,0	4,0	
New channel on Metaverse or SNS	● 5,0	○ 1,0	● 3,0	○ 0,0	○ 1,0	○ 1,0	○ 0,7	1,8	
Sales related analytics	○ 0,0	○ 0,0	○ 0,0	○ 0,0	● 3,0	○ 0,0	○ 1,0	0,5	
Recommendation & promotion	● 5,0	● 3,0	● 4,0	● 3,0	● 3,0	○ 1,0	● 2,3	3,2	
Pricing optimization	● 3,0	○ 1,0	○ 2,0	○ 1,0	○ 3,0	○ 1,0	○ 1,7	1,8	
Customer segmentation	● 3,0	● 3,0	● 3,0	● 3,0	○ 1,0	○ 0,0	○ 1,3	2,2	
Advanced consumer analysis	○ 0,0	○ 1,0	○ 0,5	○ 1,0	○ 1,0	○ 1,0	○ 1,0	0,8	
Staff support	● 5,0	○ 1,0	● 3,0	○ 1,0	● 3,0	● 3,0	● 2,3	2,7	
Store automation	○ 0,0	○ 0,0	○ 0,0	○ 0,0	○ 1,0	● 3,0	○ 1,3	0,7	
Merchandizing	● 3,0	○ 0,0	○ 1,5	○ 1,0	○ 0,0	○ 1,0	○ 0,7	1,1	
Sustainable Supply Chain									
Enterprise inventories	○ 1,0	○ 0,0	○ 0,5	● 3,0	● 3,0	● 3,0	● 3,0	1,8	
Supplier visibility	● 5,0	○ 0,0	● 2,5	● 5,0	○ 1,0	● 3,0	● 3,0	2,8	
SDG compliance	● 5,0	○ 0,0	● 2,5	● 5,0	○ 1,0	● 5,0	● 3,7	3,1	
Product compliance	○ 1,0	○ 0,0	○ 0,5	○ 1,0	○ 1,0	○ 1,0	○ 1,0	0,8	
Data-driven management	○ 0,0	○ 0,0	○ 0,0	○ 0,0	○ 0,0	○ 1,0	○ 0,3	0,2	

Retailing

Cross-industry collaboration

Learning objectives



You need to know what types of enterprise applications organizations put in place to operate and improve performance

Business processes that enterprise apps assist
Continuous need to evolve as market changes
Adopting and integrating new technologies
Fundamentals of business transformation
Sustainability-driven changes

913,000,000,000 USD

Gartner Insights Expert Guidance Tools Connect with Peers

Forecast Analysis: Enterprise Application Software, Worldwide

Published: 07 December 2023

Summary

The worldwide enterprise application software market will reach \$336.3 billion in 2023, growing at 12.0% in constant currency. The market will go on to reach \$580 billion in 2027, with a constant currency CAGR of 13.4% (2022-2027).

In 2023, IT spending on enterprise software amounted to around 913 billion U.S. dollars worldwide*

SaaS/cloud	22%
Software	22%
Services	45%
Hardware	11%

*) Source: Statista 2024

- ERP and Business Applications - things you know already
- Digital innovation
- Sustainability transformation
 - Transparency of supply chains, evidence based
 - Improving operational processes, optimization
 - Business models, reinvention
- Q&A

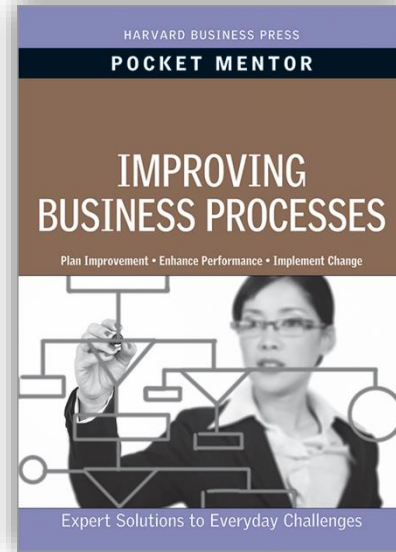
- Lecture recording – which you all (?) watched before this new lecture...

<https://aalto.cloud.panopto.eu/Panopto/Pages/Viewer.aspx?id=0952eabc-07b1-4fdb-bacf-ab5a00b33cc2>

- Introduction to ERP and Business Applications
- ERP, CRM, SCM, HRM, BI, FRM, SRM, MRP, PLM, MES, BI/BA, POS, CMS, BPM,...
- Business context and process reengineering
- Financial Accounting & Management software
- Customer Relationship Management software
- Supply Chain Management software
- Enterprise Resource Planning software
- Product Lifecycle Management software
- Business Intelligence software
- Complexity of integration and transformation
- How firms have transformed over the decades?



Organizational context
Value chain context
Business process context
Value stream context
Core and support processes
Transactional needs, daily operations
Analytical needs, decision making
Hierarchy of processes
Role of business application in all above
Business processes supported
Customer and business value provided
To manage, run and improve a business



Material flows
Workflows
Information flows
Money flows

Business model
Operating model
Value chain model
Marketing model
Sales model
Distribution model
Service model
Ecosystem model
Revenue/profit logic

Automation
Optimization
Transformation



Lidl Suffers €500 Million Supply Chain Failure

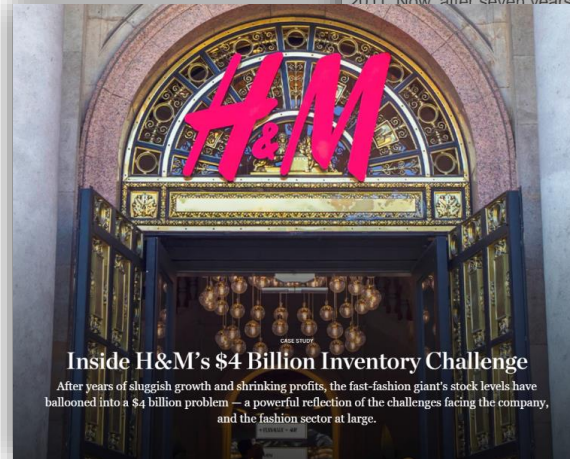
By Jamie Grill-Goodman - 10/02/2018

Grocery chain Lidl and software giant SAP planned a new inventory management system in 2011. Now, after seven years and an estimated new system with



hundreds of new company-wide own as eLWIS an), reports (17, SAP awarded their best customers. f IT, Alexander July this year, on arrival, says the report.

on scratch," a company insider told Handelsblatt.



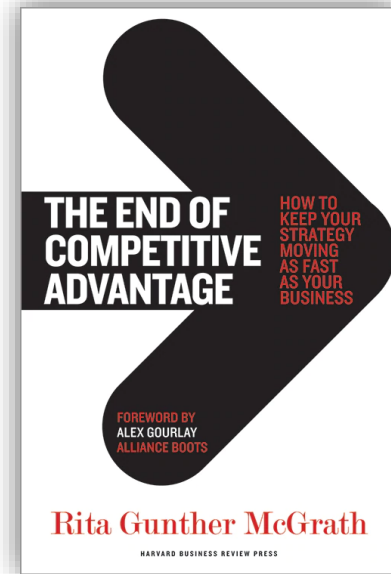
Inside H&M's \$4 Billion Inventory Challenge

After years of sluggish growth and shrinking profits, the fast-fashion giant's stock levels have ballooned into a \$4 billion problem — a powerful reflection of the challenges facing the company, and the fashion sector at large.

Often, cultural problems and resistance to change culminate in failure to define future state business processes and wants, and an overall refusal to improve business processes – instead, paying a technology vendor to address “new” requirements

- ✓ “A very good understanding of our business expectations and balancing the risks and returns of conflicting priorities underlines wide experience in our industry and line of business.
- ✓ Executing given projects with tight schedules and limited resources proves disciplined management and operational style.
- ✓ Sourcing cost effective services from outside and delivering core services from inside the organization demonstrates an ability to lead a service organization and exploit partnerships.
- ✓ During last few years you have also learned to live under cost pressure and match investments with business outcomes.
- ✓ You have delivered all our organization wants and business needs.

- ✗ As a summary: “Your days are numbered.”



Digital innovations

Digital receipt over email with social media links



Digital receipt archive with return and warranty barcodes



Classification of customer's spending, tagging/organizing of receipts



Data-driven reinvention of segmentation and marketing decisions



Platform for value exchange through supplier managed digital promotions



Digitisation

A digital service

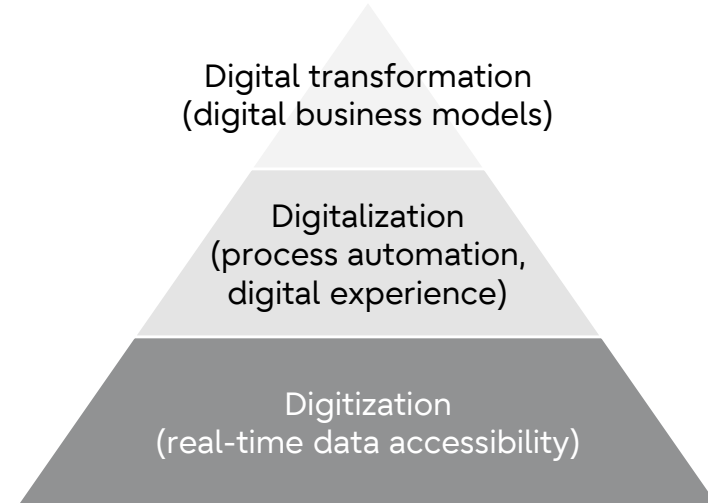
A data-driven service

Digitalization of a process

Digital transformation

Digitalization has more to do with redesigned operations than with technology

- **Selling and delivering a product according to the customer's requirements is not digital transformation or a driver of transformation**
- **It is a business process**
 - Digital processes address a subset of different economic and marketing characteristics that actually change because of retailer's actions on digitalization drivers
- **Transformation drivers are**
 - Strengthened competitiveness, improved efficiency, reduced costs, strengthened customer relationship, increased revenue, improved employee experience and transformed business models etc.
 - Key words: non-linear interaction, end-to-end visibility, demand sensing, dynamic planning, shared execution flexibility, automated decision making, cross-functional reconfiguration



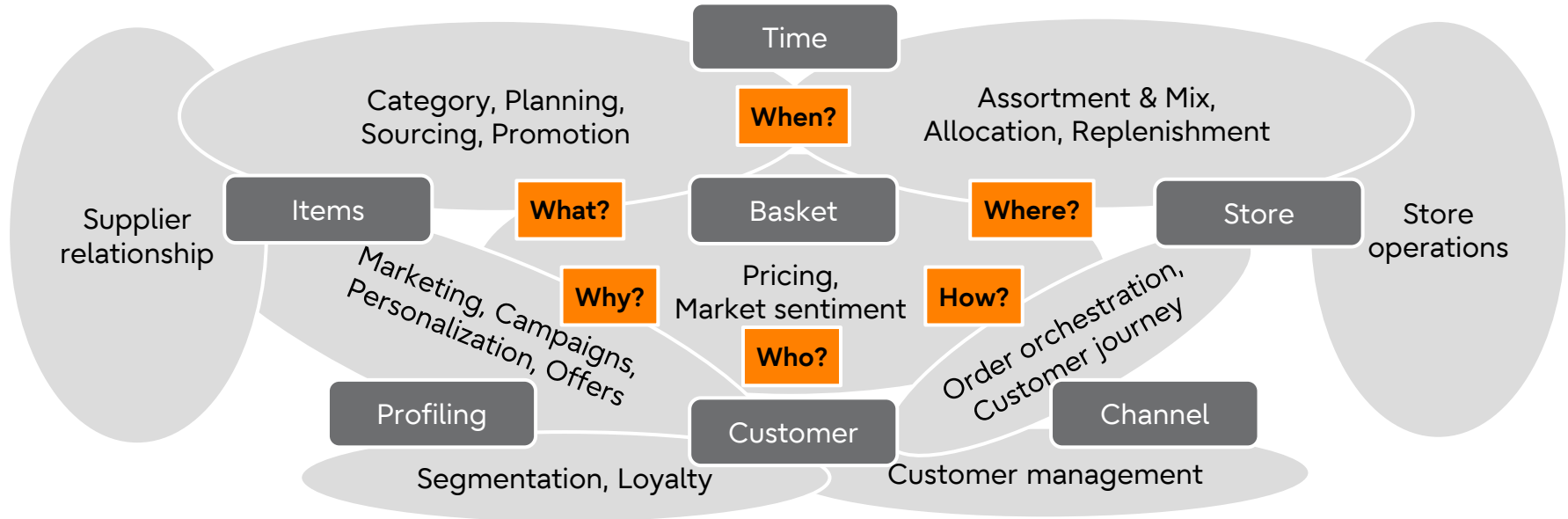
Beyond ERP > Digital data & analytics

Conversion of information and tasks to digital for cost efficiency without changing value creation activities

Altering business processes by improving co-ordination between processes to create incremental value

Reinvention of core business model to strategically develop new capabilities to redefine customer values

Many retailers best know those customers who buy less (online), and know least of those who buy most (in-store)



Beyond ERP > Platformization

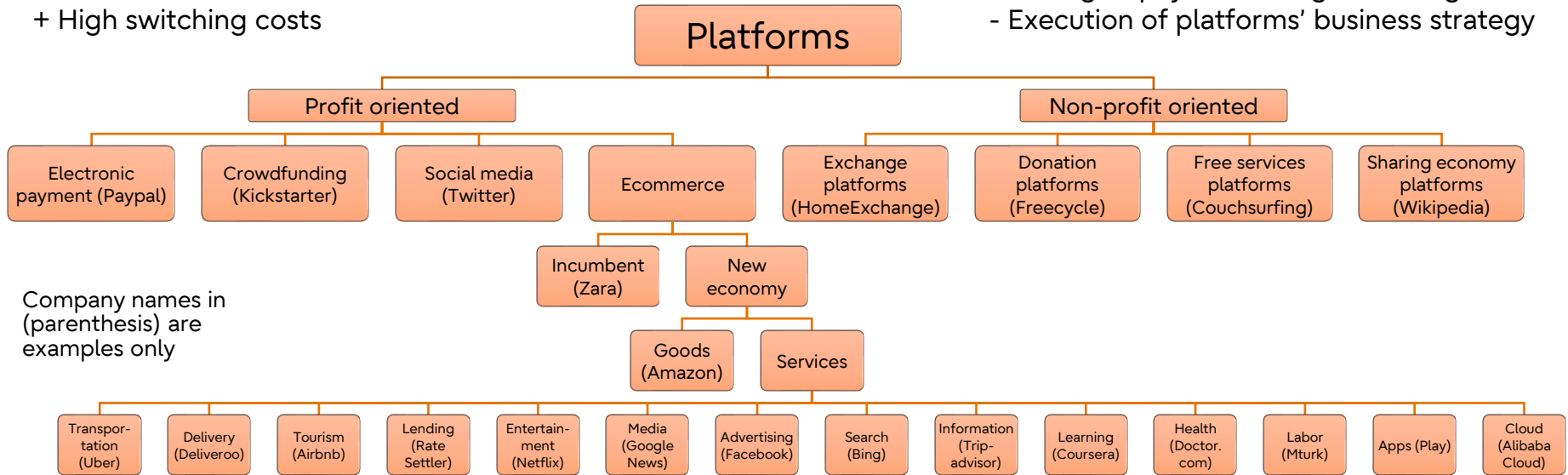
Aligned ecosystem structure along brand and store strategy

Data sharing agreements and analytics capabilities to leverage real-time data

Early partnerships to engage in new services to drive brand relevance

- + Ability to extract, control and analyze data
- + Network effects
- + High switching costs

- Risk of subordinate position
- Having to pay for the digital intelligence
- Execution of platforms' business strategy

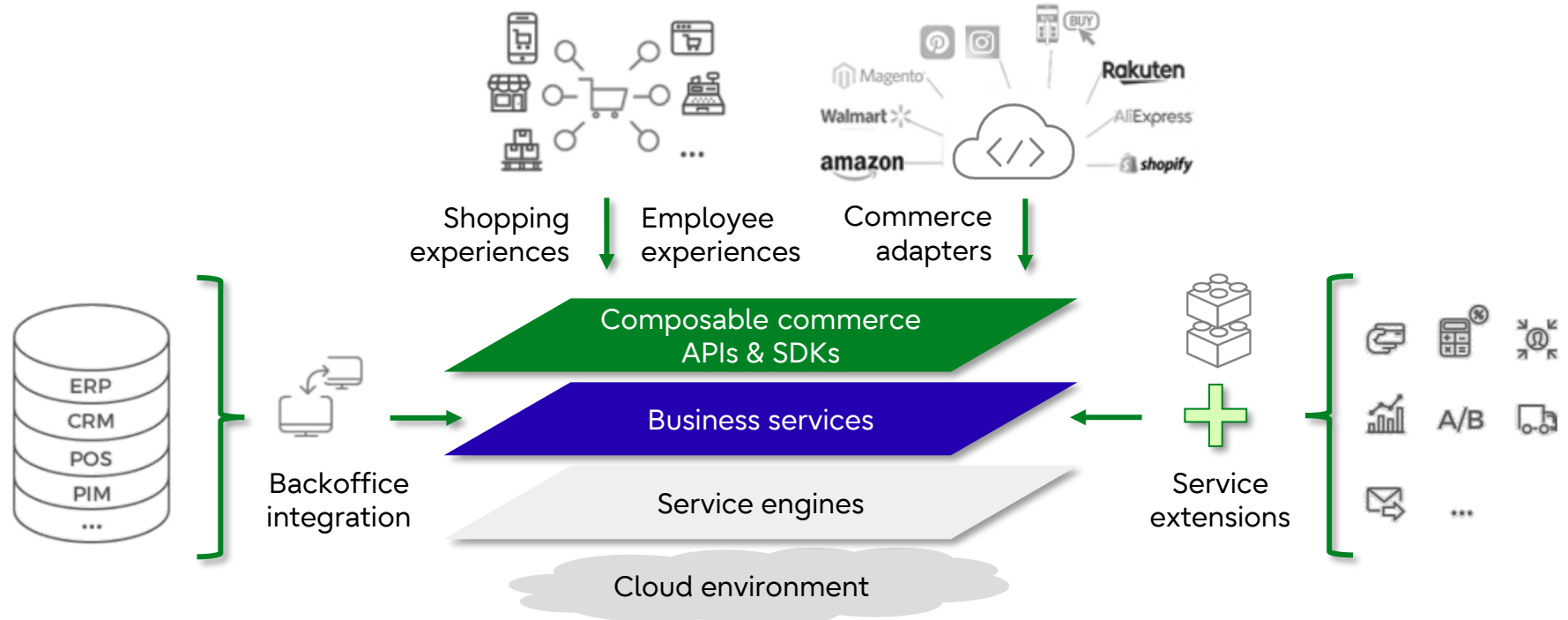


Company names in (parenthesis) are examples only

Source: modified from UNCTAD 2018

Beyond ERP > Composable

Composable commerce APIs allow companies to deconstruct their core business and drive access to new value pools more rapidly



Beyond ERP > Automation & AI

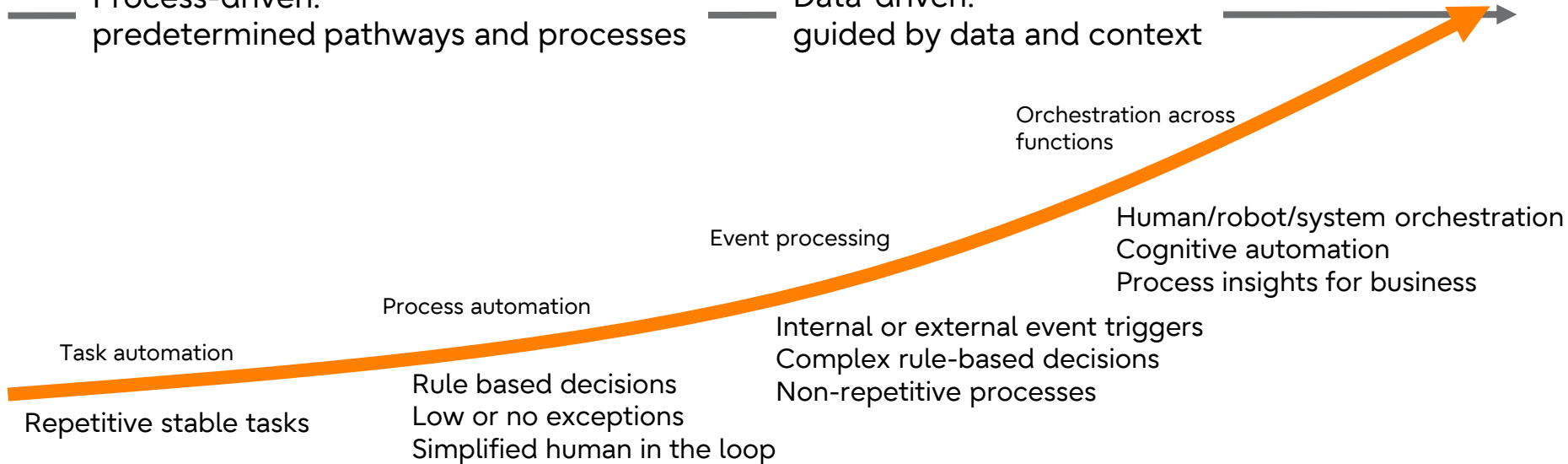
Shortages of laborers, lowering costs for automation, and increasing customer demand

Operational changes increase efficiency while supporting digital operations and innovations

AI-driven automation requires minimal manual intervention during operations

Process-driven: predetermined pathways and processes

Data-driven: guided by data and context



Transforming how a company functions

Beyond ERP > Digital data

Beyond ERP > Platformization

Beyond ERP > Composable

Beyond ERP > Automation

= That's the technical context

What are you trying to solve or achieve?

How to make use of technological possibilities as enablers and make them interwoven with the organizational life?

= Today's example is sustainability in retailing

Linkages to other lessons in your course:

- Organizational change in the digitalization era
- The role of data in the modern business
- Service design and human-centred design methods
- Challenges with big data analytics
- Responsible and strategic use of data & AI
- ...

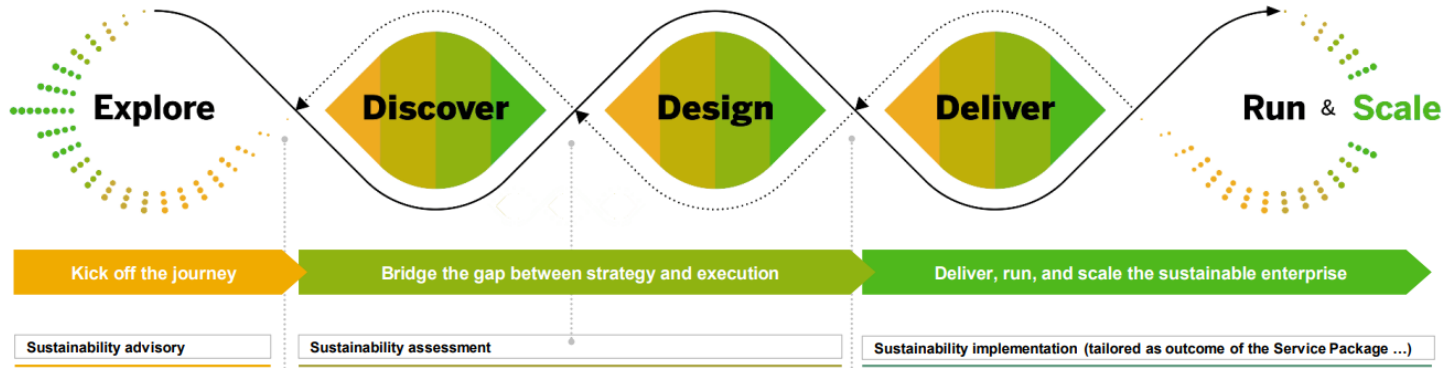
Not a project, but a functional change

- Transformation is on-going, it has no clear beginning or end, it evolves in time
 - Digitalization is not a new phenomenon, it has influenced since the 1970s, with changes that have been relatively invisible for the consumer, but today consumers are seriously involved

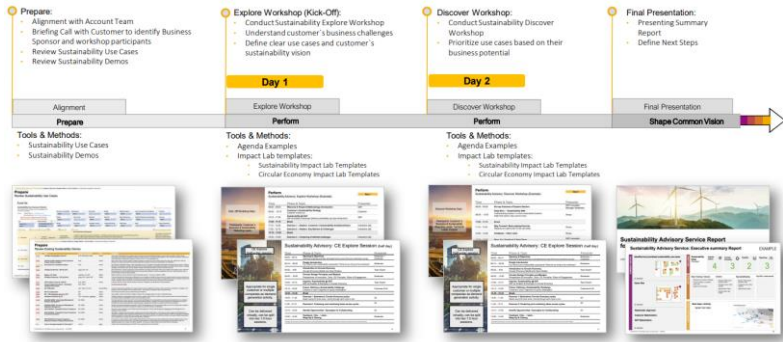
Changes impact all three main channels				
Opportunity	Description	Examples	Potential rewards	Degree of difficulty
Communication	Access and exchange of information	Omnichannel orchestration, Customer insights, Loyalty programs, Social media, Personalization, Smart shelves, Social commerce		
Transaction	Transfer of ownership and the monetary transaction	Customer journeys, Ordering process, Shopping assistants, Digital payment, Self-scanning, Dynamic pricing, Smart cart, Cashier-less stores		
Distribution	Physical and tangible exchange of products	Click-and-collect, Home delivery, Robotization, MFCs, Visibility, Traceability, Provenance, Subscription, Direct-to-Consumer, Sustainability		

- Enterprise apps facilitate essential business operations and routine transactions by integrating all data and cross-functional systems
- Sustainability has a big impact on business processes and therefore it requires lots of new functionalities to be implemented in enterprise applications
 - Address regulation vs gain business advantages
- Currently, the sustainability phenomenon is still in the infancy phase in the ERP domain, and large companies such as SAP and Microsoft are yet attempting to frame the concept of sustainability and are exploring various approaches to incorporate sustainability

In other words: it's a consultancy market

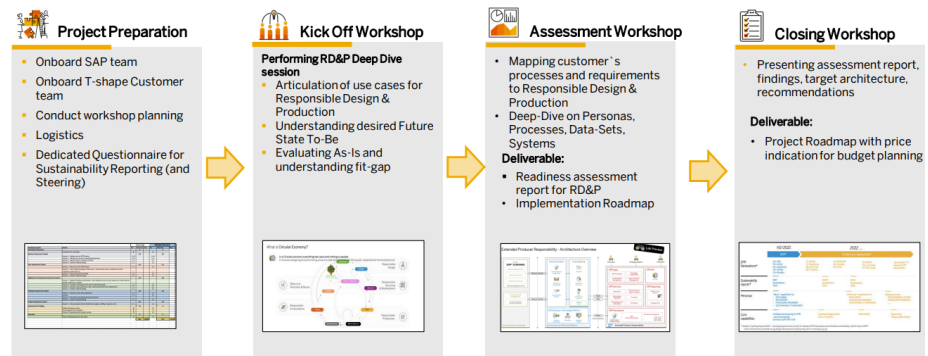


Advisory



Example: SAP Sustainability Service Package

Assessment



My not so scientific research on March 15th

Google

"Consumer experience with sustainability" x

About 9 results (0,38 seconds)

Google

"Business impact of sustainability" x

About 48 500 results (0,26 seconds)

Google

"Business impact of sustainability" x

About 48 500 results (0,26 seconds)

Google

"Business of sustainability "

About 1 070 000 results (0,22 seconds)

This lecture
(leverage digital,
transform operations,
deliver the sustainable)

Some other lecture
(greenwash,
make money,
repeat)

Critical position in the value chain

Sector's economic significance

Environmental externalities

Shift to sustainable business models

Institutional agenda



Retailers implement sustainability on environmental-legal-financial drivers

Social implications: retailers “shift” their responsibility to the consumers rather than encourage themselves to make more sustainable choices because of the inherent trade-off between revenue growth and sustainable consumption

= Narratives of communication with the focus on persuading consumers to buy their “sustainable” products



[Schwarz Group Lidl](#) is scrapping all ‘Use By’ dates on all own brand milk and yoghurt in the UK – starting in early 2024. The move is part of the discounter’s plan to tackle food waste, as it encourages shoppers to use their judgement on whether products are still good to eat.

December 2023

'Talk the talk AND walk the walk'



Building relationships based on values and culture

'Closing the loop on green credentials'



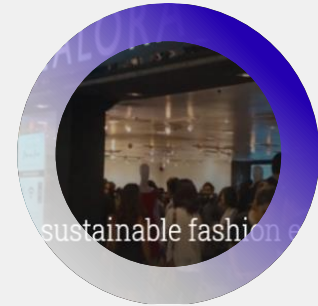
Sustainable retail and the circular economy

'Cleaner, greener commerce'



Rising demand for green delivery

'The fast ticking-clock'



Countdown to Net Zero Retail

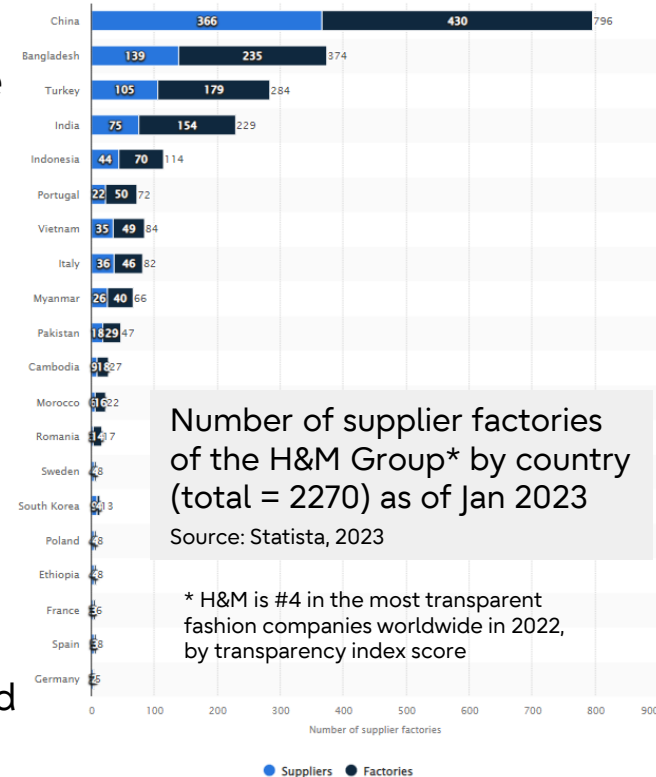
Social consumption	Consumption choices	Sustainable production	Resource management	Carbon & climate action
Rethink ways of consumption to reduce footprint	Measure and communicate product impact	Drive innovative product solutions	Close the loop on materials and adapt merchandizing	Rethink ways of working to reduce footprint
Facilitate multi-faceted ways to deliver a product which also encourage reduced consumption	Informing choice around diets and environment; transparency in product information; influence shoppers' basket-building process	Sustainably sourced; plant-based alternatives; protecting scarce resources; promoting Biodiversity	Packaging (reduce, reuse, recycle programs); waste reduction Initiatives; outlet' store for discontinued, reconditioned or slightly defect product	Renewable sources; energy efficiency across stores, distribution, logistics, and broader product supply chains; in-store services for EV charging dwell time

Sustainable supply chains

Supply chain management, Enterprise resource management,
Item management, Product Lifecycle Management

Just how big those supply chains are?

- An apparel company might think that they only have 1000 – 2000 suppliers the reality is likely to be 20,000-50,000 if you include all sub-suppliers*
*According to 'The Business of Fashion and McKinsey and Company'
- Currently little visibility between production and point of sale
 - Consumers demand variety and affordability, and are unaware of the social and environmental impact of their fashion consumption but exhibit high demands for new items
 - “Eco-Friendly Label” is sometimes an indication of one supply chain path made transparent
- Collaborations and initiatives between major brand owners in improving sustainability
 - Also to reduce duplicated auditing and to set controls standard



Gaps in existing enterprise applications

- Supply chain data collection to demonstrate sustainability credentials
 - Visibility into the upstream supply chain to improve demand planning, reduce waste and eliminate overproduction
 - Supply chain transparency to support product traceability and ensure ethical sourcing and sustainable production
 - Ability to consolidate shipments and optimize transportation across multiple manufacturing partners
 - Commerce capabilities needed if moving towards rental services in lieu of product ownership
 - Data insights to build subscription products that can predict when consumers will need a new delivery
 - Optimized consolidation of picking and shipments when fulfilling online orders
 - Improved distribution/fulfilment logistics to reduce transportation
 - ... and much more
- = DLT/blockchain
 - = Data analytics
 - = Artificial intelligence
 - = Data visualization
 - = Augmented reality
 - = IoT/RFID
 - = Collaborative IS
 - = Omnichannel commerce
 - = Social/Live commerce
 - = Privacy
 - = Store robotics
 - = Shelf monitoring
 - = Workforce tools

Poll: fast fashion, which of these is correct?

A

Laundry causes the equivalent of 3 billion polyester shirts of plastic microfibres to be released into the ocean every year

B

Fashion industry produces up to 10% [estimates range] of the global total greenhouse gas (GHG) emissions

C

About 60% of all fibers used in fast fashion are made from plastics because it is cheap and versatile

D

Global apparel production is projected to rise, so that in 2030 equivalent to more than 500 billion additional T-shirts will be made



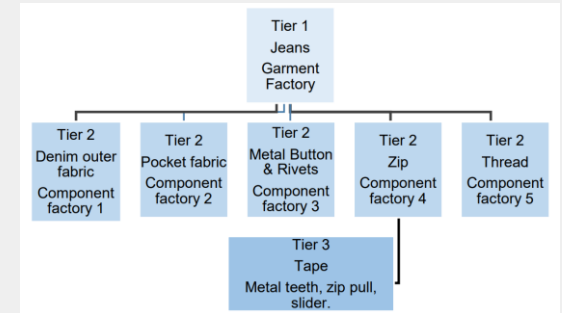
Fast fashion, which of these is correct?

Correct answer(s) provided during the lecture

Substantial environmental and social footprints

- **70% of emissions came from upstream activities: materials production, preparation and processing**
 - 30% are associated with downstream retail operations, the use-phase and end-of-use activities
- Complex supply chains, social complexity, geographical dispersion and fragmentation of production, high levels of pollution, high volume, and generally low profit margins
 - Weak direct control over upstream activities, while remaining fully responsible for their product/service lifecycles
 - Frequent trade-off situations among the three dimensions of sustainability and the different actors of supply chains (environmental, social, governance)

3-tier supply chain for a denim jean

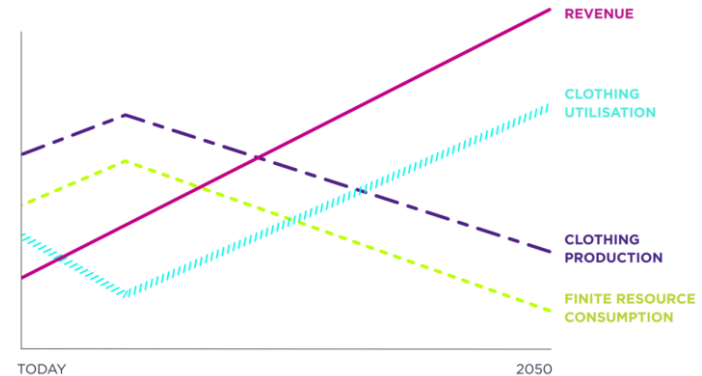


Difficulty in accounting for and ensuring that all suppliers are sourcing ethically and acting sustainably becomes clear

“Take-make-waste” business model

- Fast fashion industry has experienced ever growing levels of production, coupled with shrinking profits and increasing negative environmental impacts
- Clothing production doubled between 2000 and 2015 while, during the same period, utilization decreased by 36%
- Due to ever lower prices and lost revenues – from overstock, stockouts, and returns – profit margins of the world’s leading apparel retailers decreased by an average of 40% from 2016 to 2019

Fast fashion allows consumers to make choices, with little economic or psychological investment, whilst expressing their lifestyle through consumption and possession



Fast fashion industry is looking how to decouple revenues and growth from production and resource use

- Retailers need to solve the problems of integration and sustainability

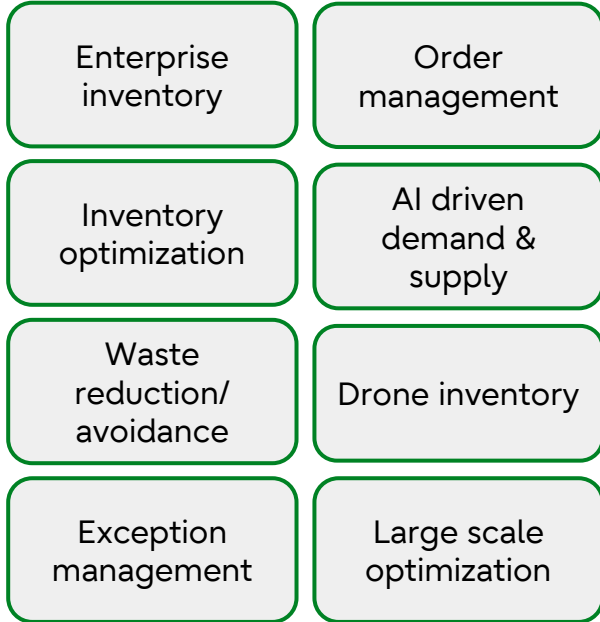
- Achieving sustainability requires a holistic changes into not just product and manufacturing processes, but also the entire supply chains, including the manufacturing systems across multiple product life-cycles, improved data models, performance metrics and optimization techniques at the product, process, and system levels



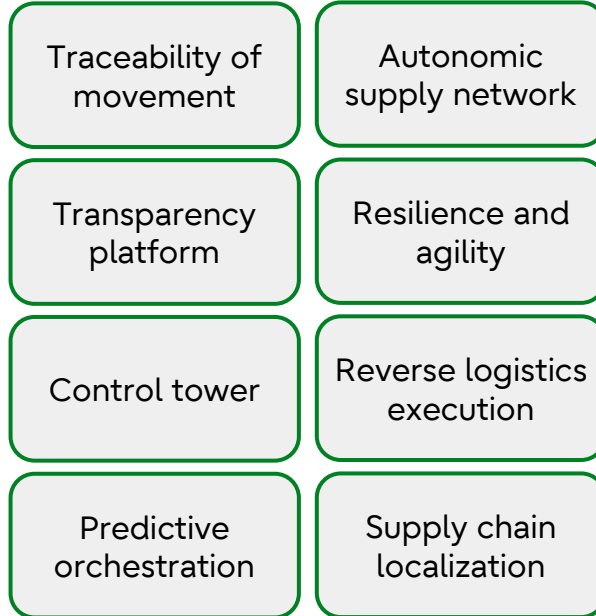
- Emerging/maturing means:

- Sustainability control tower
 - Visibility, decision-making, understanding of environmental impacts
 - Accounting for and managing climate-related data across all parts of supply chain (scope 1, 2 and 3), including suppliers, contract manufacturers, logistics service providers and trading partners
- Automated demand forecasting and planning, and inventory management
 - Anticipates, understands, and adapts to external factors

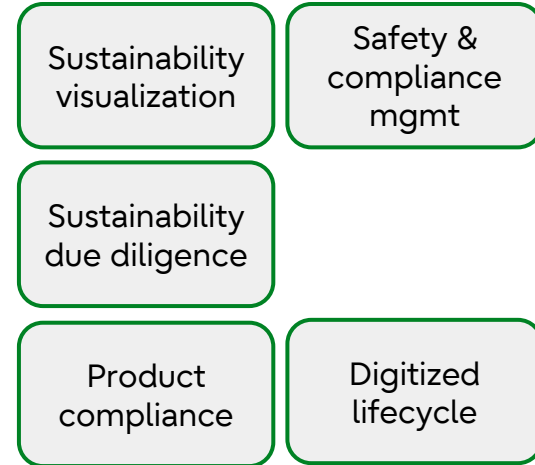
Enterprise inventories



Supplier visibility



Compliance



New application modules



Climate and Natural Capital Accounting

Build true cost values into end-to-end management of enterprises and across business networks

SAP Product Footprint Management*

Reduce GHG emissions along the value chain

Product Carbon Footprint Analytics

Product-level GHG analytics

Business Ecology Management for Small and Midsize Businesses*

Product-level natural capital accounting for SMB nodes in the supplier networks of larger enterprises

SAP Environment Management

Emission management and carbon tracking

E-Mobility*

Maintain your electric car fleet

Sustainable Travel (Concur)

Understand and mitigate your CO₂ emissions caused by business travel



Resource Productivity, Tracking, and Reuse

Building resilience and circularity principles into supply chain, material flows, markets, and resource consumption

Responsible Design and Production*

Sustainable packaging reporting/extended producer responsibility/scenario modelling

Responsible Sourcing and Marketplace*

Supplier risk, ethical sourcing, and secondary marketplace

SAP Rural Sourcing Management*

Responsible sourcing

GreenToken

Co-mingled raw material tracing

SAP Ariba Supplier Risk Management *

Responsible sourcing

Resource Recovery and Reuse*

Downstream material analytics solutions to support extended producer responsibility, waste infrastructure investment, and responsible sourcing

Responsible Consumption*

CX solutions to engage customers in sustainable brand and product experiences

SAP Logistics Business Network*

Material traceability solution



Next-gen Sustainability Performance Management

Mapping operational data to show impact with holistic sustainability reporting to enable sustainable business steering and decisions

SAP Sustainability Control Tower (Corporate Sustainability Reporting and Steering)*

Next-gen sustainability performance management

SAP Profitability and Performance Management

Sustainability acceleration package



Protecting People, Communities, and Societies

Ensuring continuous improvement in safe, equitable, and compliant businesses, within the company and across the value chain

SAP Environment, Health, and Safety

Reduce risks to foster safe operations

Success Factors

ISO 30414 human capital reporting

SAP Qualtrics

Manage your customer sustainability engagement

SAP Business Integrity Screening

Anomaly detection and prevention to mitigate fraud risk and reduce losses

SAP Product Compliance

Product and chemical compliance-safety data sheet, label, and dangerous goods management

* planned

Example: SAP Enabler Strategy for the Sustainable Business

- Example: Inditex
- Ensuring the traceability and thorough knowledge of suppliers and manufacturers
 - Ability to identify and trace the history, application, location and distribution of products, parts and materials
 - Requiring each supplier to share all the data of their own supply chain in traceability management system
- Applying solid social and environmental sustainability standards and requirements to our suppliers and manufacturers
 - Decent working conditions (Inditex provides employment to more than three million people)
 - Sustainable production, responsible water management, use of renewable energy sources, reduction of CO2
- Responsible purchasing practices (the way suppliers are interacted and negotiated with)

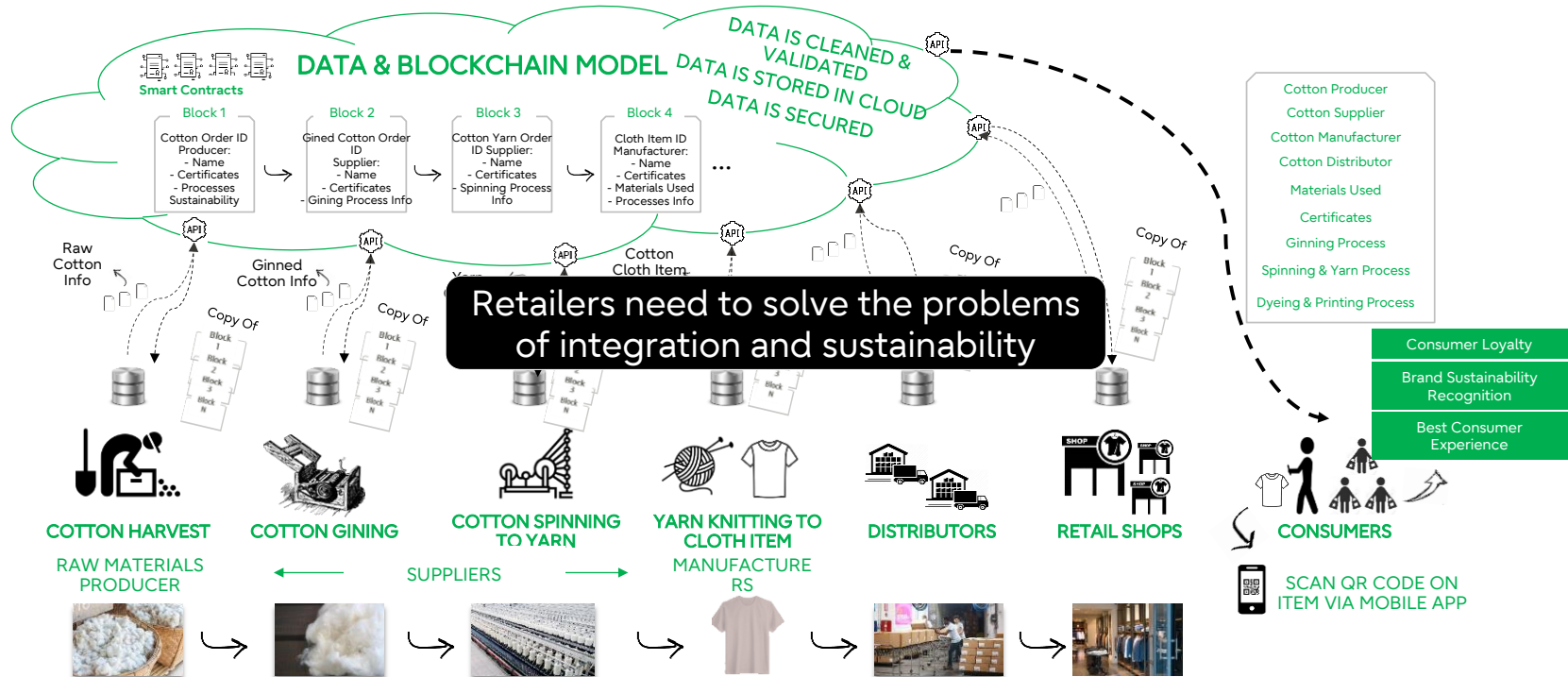
Inditex* supply chain in 2021



* ZARA, Bershka, Resto, Pull&Bear, Massimo Dutti, Stradivarius, Oysho

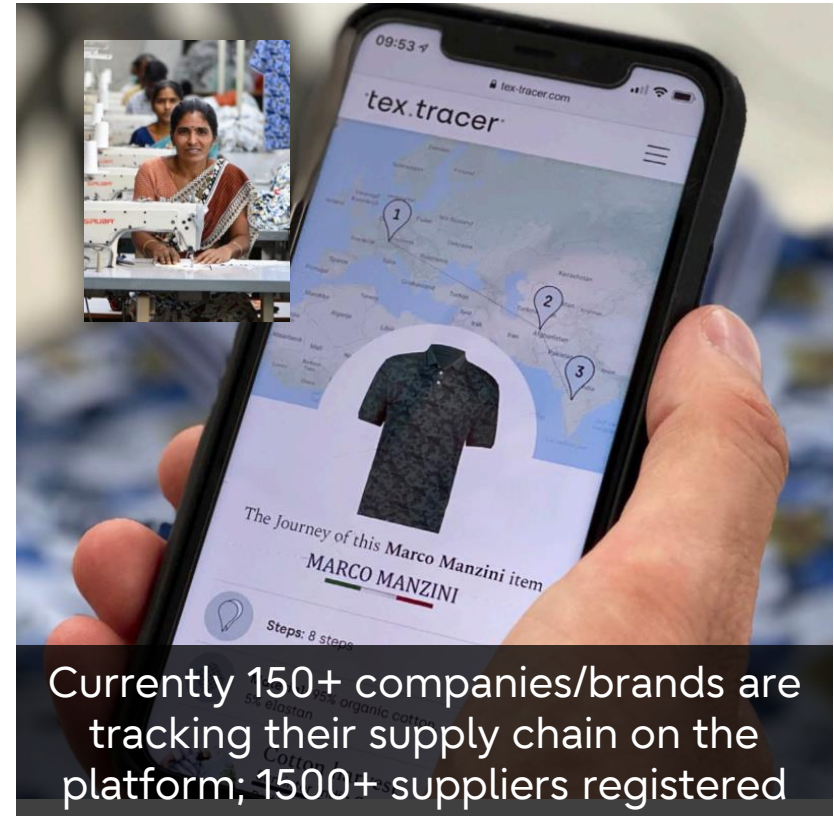
Sustainability in clothes supply chain

Coherence with policies → Marketability of brand (symbolic) → Process efficiency (substantive practice) → Competitive SDG advantage → Long-term business value



- Tracing garments through supply chains
- Bringing transparency to ethical and environmental issues in fashion industry
- Data about each step of a product's journey
- DLT/blockchain based platform
 - Data is verified using mobile geolocation, time stamps and digital handshakes, certification, and automated checks; system will not accept data entry with detected anomalies
- Optimization of resources
- Identifying operational frictions (e.g. delays)
- Confirm authenticity of a product, reduce compliance burden,...
- QR codes on a garment for consumers to trace their garment's history, enabling consumers to make educated decisions

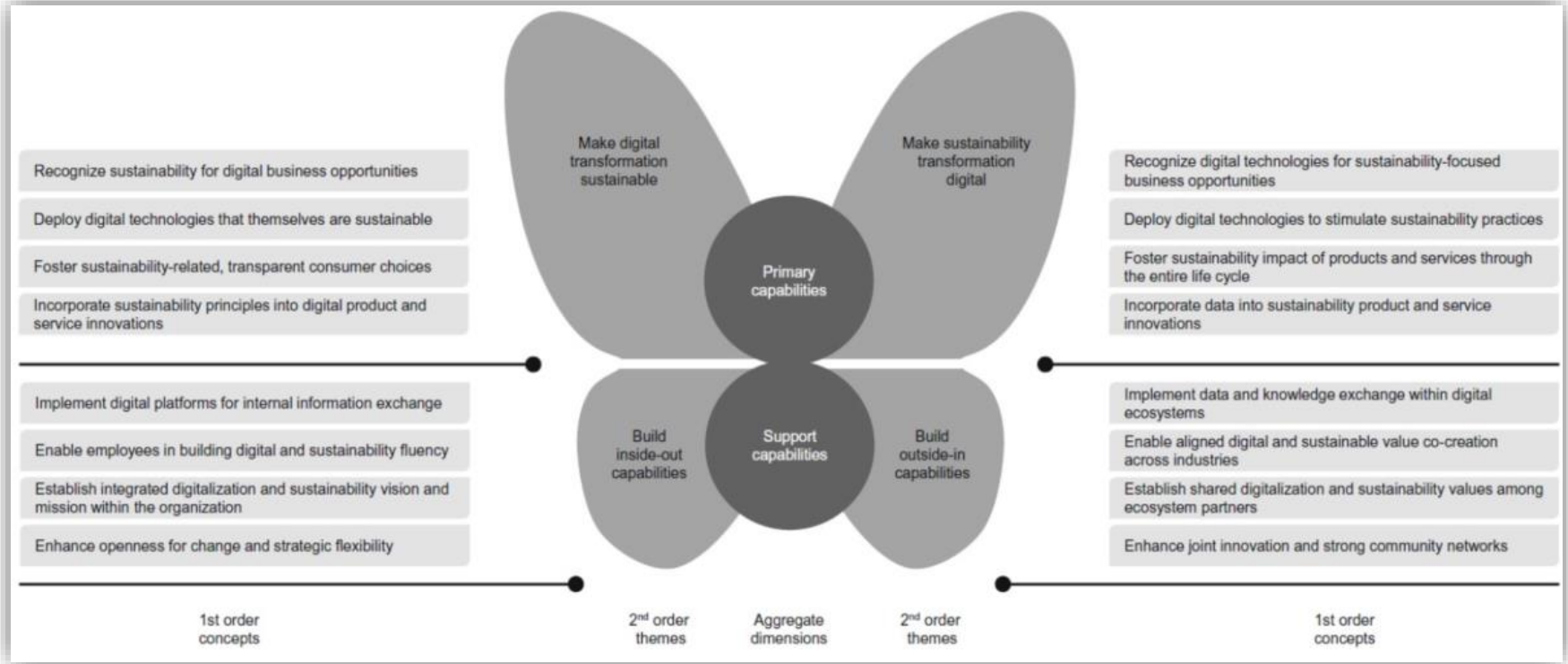
tex.tracer



Currently 150+ companies/brands are tracking their supply chain on the platform; 1500+ suppliers registered

Twin transformation

A value-adding interplay between digital and sustainability transformation



Source: Christmann et al, 2024, cited in lecture by Johanna Bragge, Feb 27th 2024, p.75

Sustainable retailing

Assortment optimization, Merchandize allocation, Shelf space allocation, Price optimization, Markdown optimization, Demand forecasting, Inventory optimization, Replenishment optimization, Store operations, Warehouse layout optimization, Workforce optimization, Order batching, Order picking optimization, Shipping consolidation, Delivery routing



International Journal of Production Economics

Volume 212, June 2019, Pages 155-167



Multi-period price optimization problem for omnichannel retailers accounting for customer heterogeneity

Manoj Kumar Tiwari

Mathematical Problems in Engineering
Volume 2017, Article ID 7964545, 11 pages
<https://doi.org/10.1155/2017/7964545>

Research Article

A Study on the Optimization of Chain Supermarkets' Distribution Route Based on the Quantum-Inspired Evolutionary Algorithm

Bi Liang^{1,2} and Fengmao Lv³

Improved Approximation Algorithm for the One-Warehouse Multi-Retailer Problem

Authors

Retsef Levi, Maxim Sviridov

A Comparison of Optimization Algorithms for Practical Staff Scheduling Problems in Logistics and Retailing

Maik Günther¹ and Volker Nissen²

¹ Baumkirchner Str. 29a, D-81673 Munich, Germany

An Algorithm and Demand Estimation Procedure for Retail Assortment Optimization

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June 2009, Revised May 2011

Optimizing Shelf Space Allocation in Grocery Retail

Journal of Retailing Manuscript # MS 2

Joint Optimization of Product Price, Display Orientation and Shelf-Space Allocation in Retail Category Management*

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IFAC-PapersOnLine

Volume 49, Issue 12, 2016, Pages 1685-1690

Optimisation of the replenishment problem in the Fashion Retail Industry using Tabu-Bees algorithm

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Retail Store Workforce Scheduling by Expected Operating Income Maximization

Authors

Authors and affiliations

Solving these problems optimally in real time would be game changing

What issues there are in business apps?

Full optimization is considered unobtainable due to calculation complexity/cost

The inability to break through the glass ceiling has meant that we gave up on the potential for greater productivity, cash, efficiency, flexibility, etc.

The optimization 'glass-ceiling'

Traditional approach towards optimization

The optimization cost/benefit trade off



Business outcomes

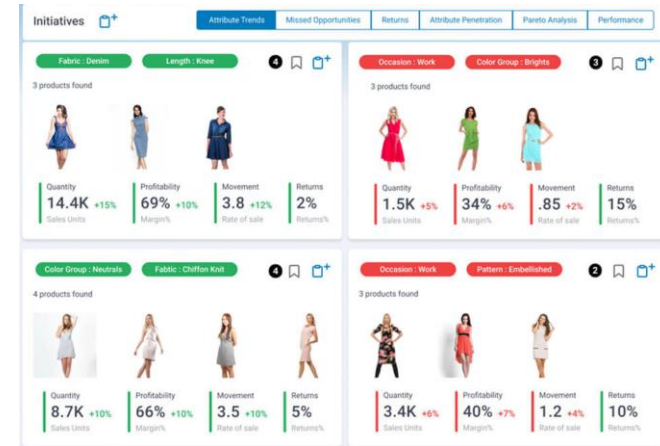
Cost of optimization and change



At a certain point, the cost/time of optimization is too great to justify the likely business outcome benefits

Offering fast fashion products

- How to optimally select the subset of fashion products to offer that cater to diverse tastes, and how much inventory to procure?
 - Balance expected revenue and inventory costs by identifying a subset of products that can pool demand and cater to diverse tastes from the universe of products, without excessively cannibalizing revenue due to the substitution behavior of customers (assortment optimization)
- Dynamic process: demand of each product will depend on what other products still exist in the selection
 - Customers in the presence of a product have one behavior, and in the absence of that product, have other behaviors
 - If there are two products, adding a third, depending on which third is added, the forecast for all three will change – leading to an exponential number of possibilities for forecasts



Picture: Assortment Management that considers qualitative and quantitative strategies by incorporating insights and historical data., Blue Yonder

Optimal product prices & product assortment are two fundamental problems in revenue management

Input: assortment of products offered

Output: purchase probability of each offered item

Characterize the choice behavior of consumers when facing a subset of products (modeling)

Balance expected revenue and inventory costs by identifying a subset of products that can pool demand from the universe of products (calculation)

Finding the revenue maximizing set of products to offer to customers is 'NP-hard' even if each product could only transit to at most two products!



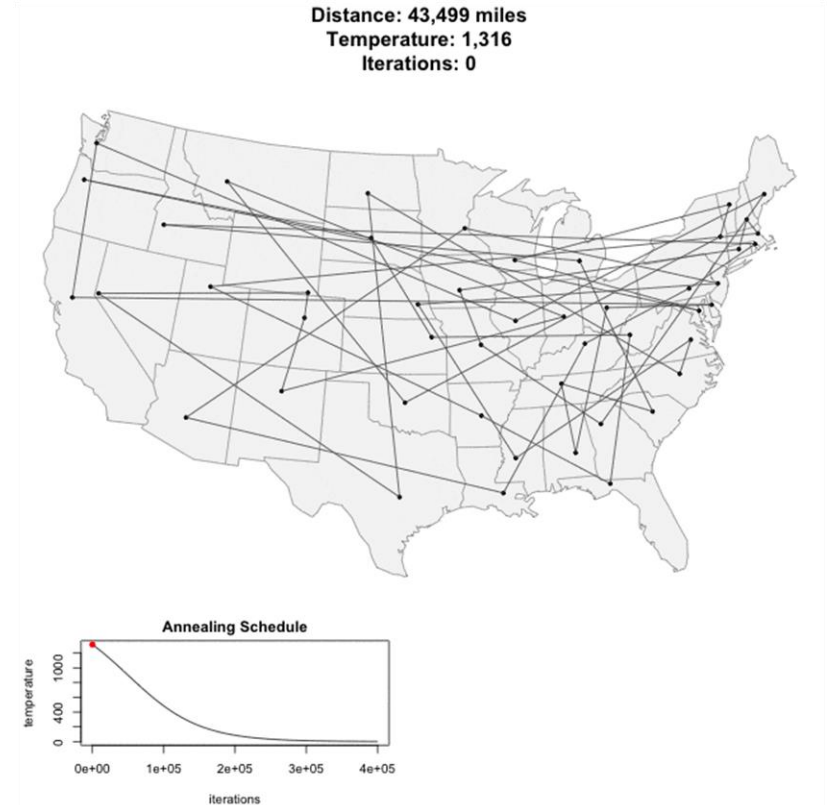
1. Customer arrives at shop, but the product is out-of-shelf
2. Store associate recommends – only once – a subset of available products as alternatives (and can control which to recommend)
3. Customer either purchases a product or leaves after one transition

Many problems are exponentially difficult

Combinatorial optimization:

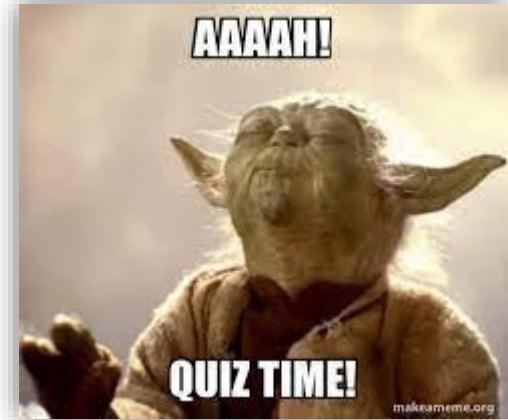
Finding the shortest route that visits each city exactly once and returns to the origin city

With 5 cities there are 12 possible routes but with 32 cities... we are dealing with 4.1×10^{33} routes



Poll: traveling salesman, 32 cities, each city once, calculate shortest route with a supercomputer...

- A Takes less than 1/10th of a second
- B Is waste of time as route efficiency improvement would be negligible
- C Is not needed, can be done with Excel today
- D Takes billions of years



**Poll: traveling salesman, 32 cities, each city once,
calculate shortest route with a supercomputer...**

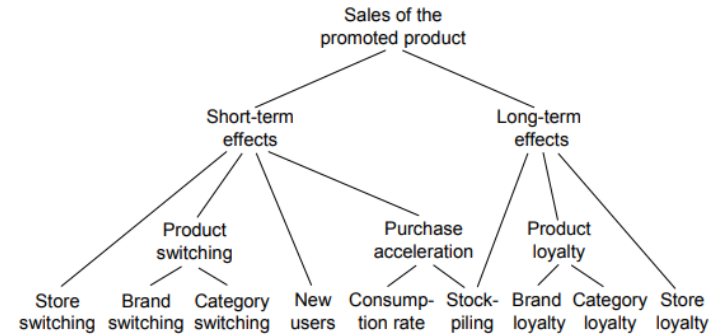
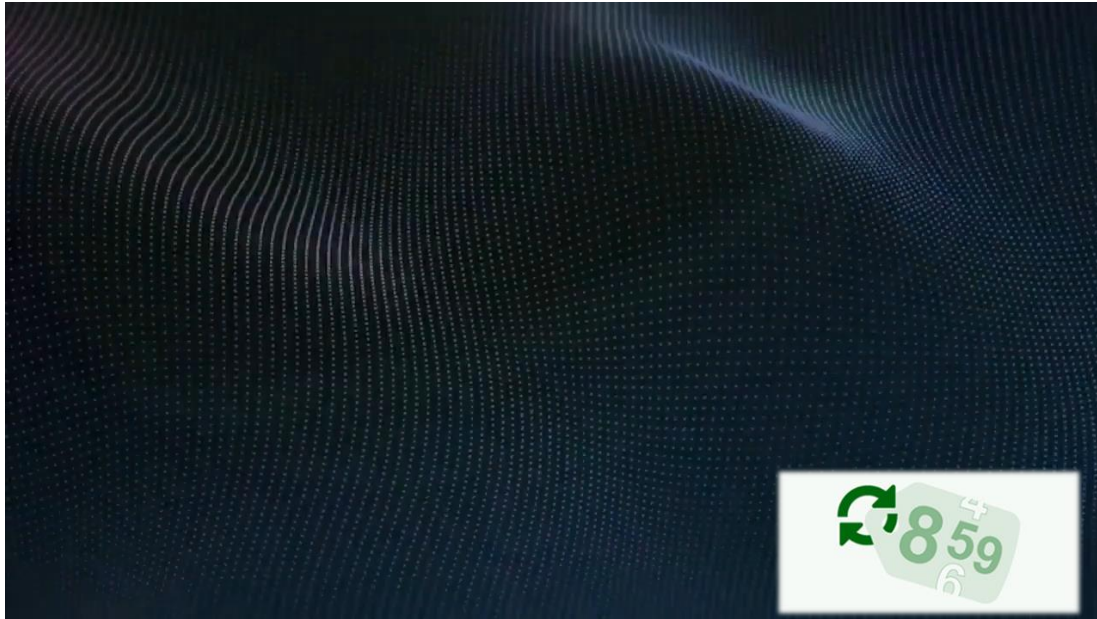


Correct answer(s) provided during the lecture

Beyond ERP > multi-item dynamic pricing

(same with assortment optimization)

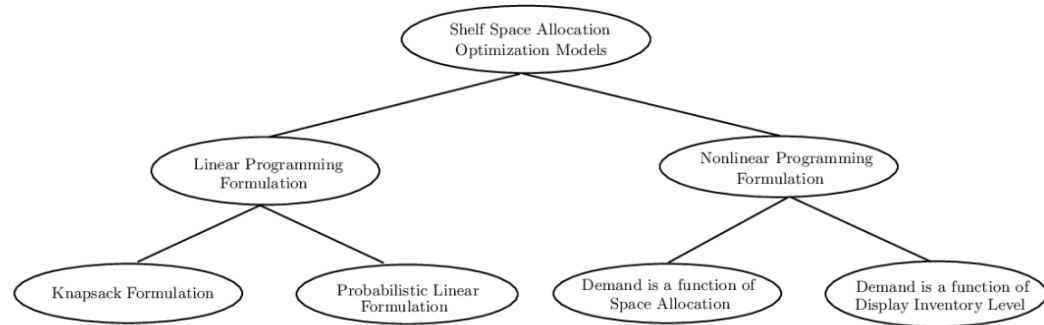
Maximize the total profit by choosing prices for several items over the selling season, while satisfying several business rules



Account for seasonality effects, post-promotion dip effect, cross-item effects etc.

Beyond ERP > shelf space allocation

Divide available shelf space between a given set of products so that the need for restocking the shelves is reduced and the opportunity cost in the form of lost sales is minimized



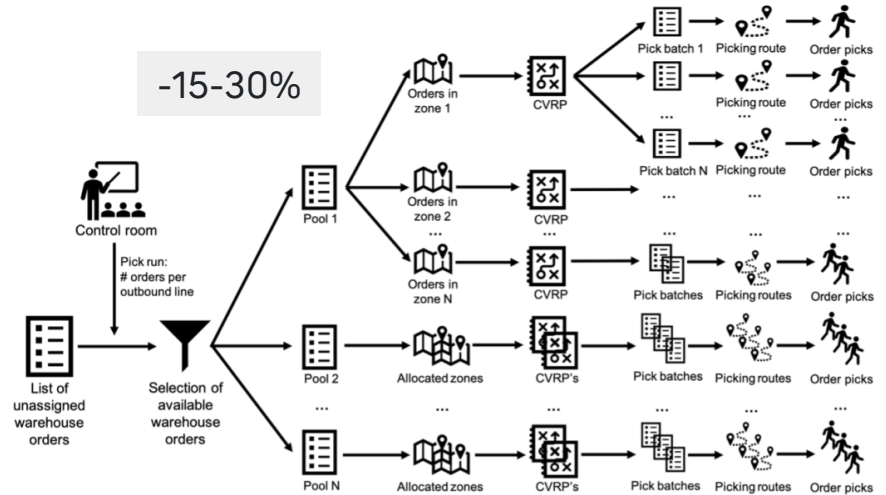
Function to be minimized is the expected quantity of lost sales; where main constraint is the available shelf space

- Processing of multi-order picking in warehouses is an NP-Hard problem

- Determine which of the available orders should be released into the picking process, e.g. every 15 minutes
- Multi-orders are selected and added to pools, which are groups of orders (assigned to one or multiple zones) to ensure their items can be compiled efficiently after they are picked
- Picking routes are created within each zone

- Goal: reduce the average time per pick of all processed items over an entire operating day

- Boundary condition is the calculation time of algorithms, which can not exceed more than a few minutes for orders of all packing stations
- Restrictions: departure times, workload on packing stations,...

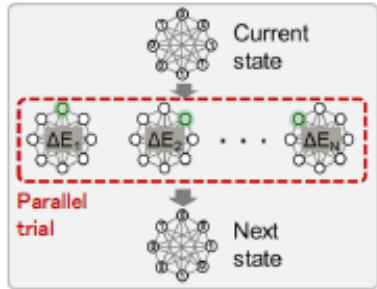


Efficiency of multi-order picking process depends very much on the right sequence and configuration of the orders

Quantum inspired digital annealing

Stochastic parallelism

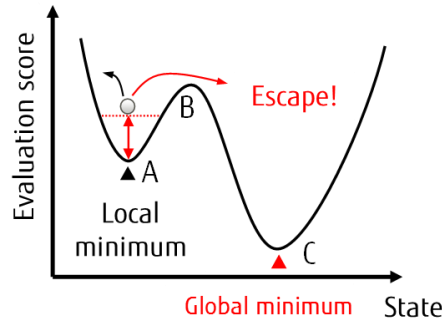
Evaluates all subsequent candidate states, arising from all possible bit flips (energy states), in parallel



Inspired by quantum parallelism (superposition)

Annealing process

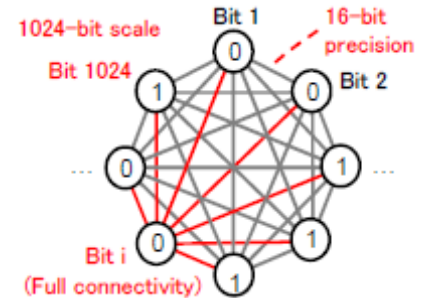
Simultaneously evaluates multiple energy potentials, avoiding local minimum traps



Inspired by quantum tunnelling

Easy Problem Mapping

Full-connectivity across all bits provides the ability to represent a large scale problem effectively



Inspired by quantum entanglement

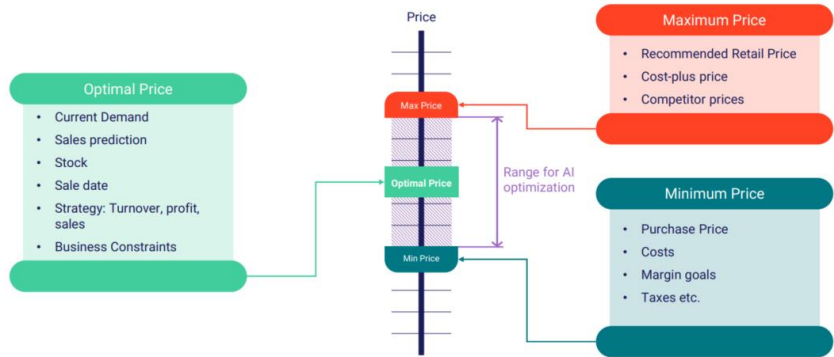
Dealing with uncertainty with the help of AI

- Using algorithms to handle stochastic estimates
 - Stochastic refers to something that cannot be exactly predicted because it contains a component of randomness
- Example: replacing static safety stocks (statistical analysis, normally distributed) for fresh products with probability-based optimization to capture how demand volume and uncertainty fluctuate
 - Optimize the trade-off between risk of waste and risk of lost sales
- Stochastic, in the context of AI, refers to the introduction of probability into algorithms and models; it allows for the incorporation of uncertainty, enabling the algorithms to handle noisy or incomplete data effectively

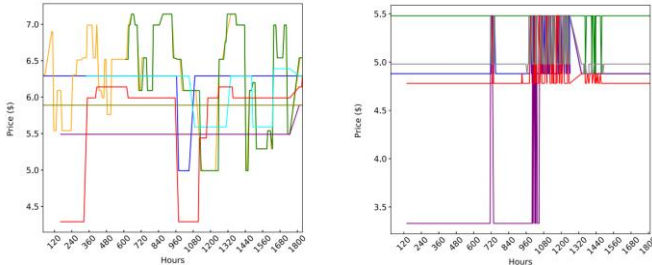


On average, 1% price increase translates into 8.7% increase in operating profits

- Source: Using big data to make better pricing decisions, McKinsey & Company, 2014



Prices of a Diet Coke (12 fl oz 12 Pack) over the course of 3 months on Amazon Fresh and Walmart Grocery across locations and hours



Diet Coke Source: The pricing strategies of online grocery retailers, Aparicio et al, Quantitative Marketing and Economics, 2024

Algorithmic pricing in online grocery:

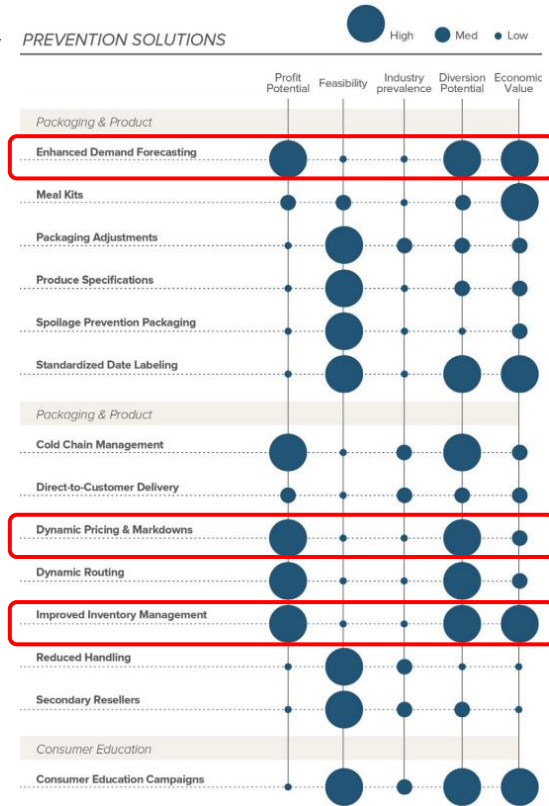
- Extremely frequent price changes, remarkably high temporal price variation
 - Probability of a price change intra-day is 7%
- The average probability of a price change within two consecutive days exceeds 17%
 - For a retailer offering 20K products in a delivery zipcode, it means 2 price changes per minute
- Price changes are significantly smaller
 - Close to 70% of daily price changes are within 50 cents
- Price discrimination across markets
 - Different prices for an identical product across different delivery zipcodes within the same retailer

Solutions for food waste

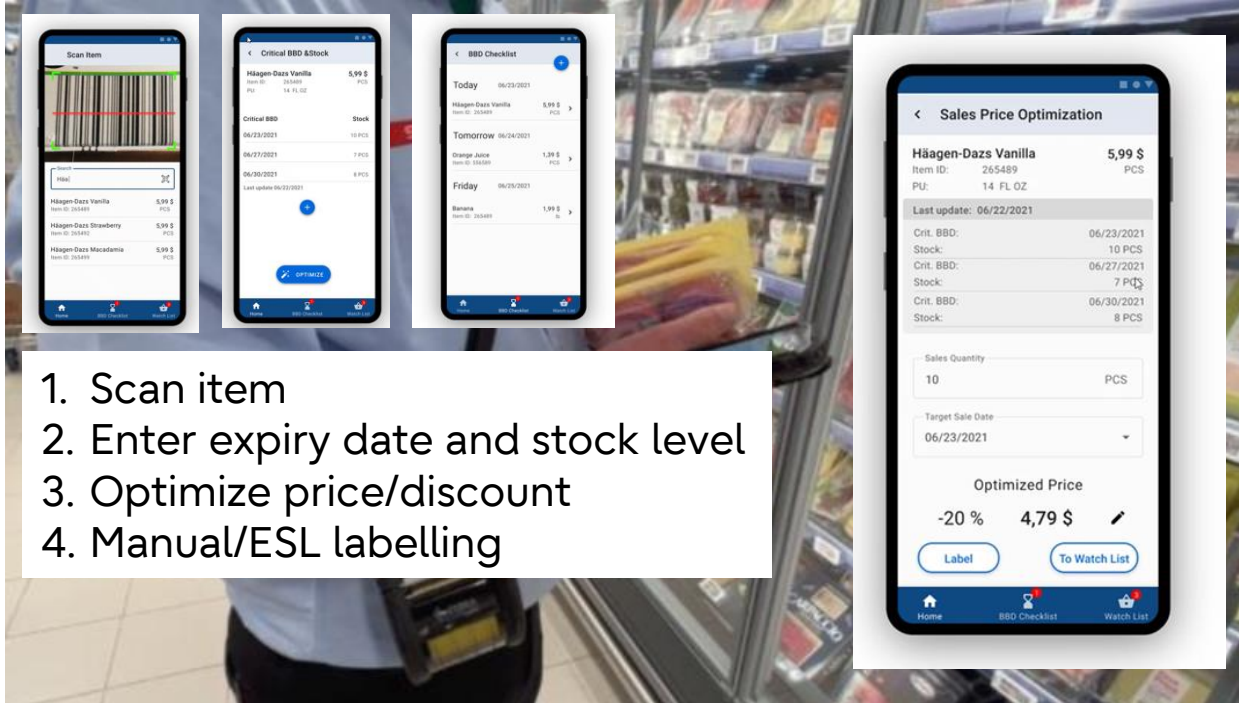
- 33-40% of the food produced worldwide is lost annually
 - Retail and food service industries are responsible for 118 million tons
- At European grocers, the costs associated with food waste are around 1.6% of net sales on average, and almost 4% for the worst retailers
 - Given that margins of grocery retailers are usually 2–3%, reducing food waste can 2x profit
- AI software is shown to reduce supermarket food waste by a third



Picture: Retail Food Waste Action Guide, ReRED, 2018



Dynamic markdown pricing (AI-based)



1. Scan item
2. Enter expiry date and stock level
3. Optimize price/discount
4. Manual/ESL labelling

- Dynamic pricing system for products nearing expiration dates
 - Cutting food waste and boosting sales
 - Avoid early/excessive discounts
 - Optimize stock and markdowns for a given expiry date
 - Reach zero stock by target sale date while preserving margin
- = Integrating shelf life into pricing

Value-based reinforcement learning algorithms to maximize the long-term reward

$$V_t(s) = \max_{a \in A} \left\{ \sum_{i \in I} \underbrace{P_i(i, a, s)}_{\text{probability}} \cdot \left(\underbrace{r(i, a, s)}_{\text{today's reward}} + \gamma \cdot \underbrace{V_{t+1}(\Gamma(i, a, s))}_{\text{best disc. exp. future rewards of new state}} \right) \right\}$$

Sustainable consumption

Customer relationship management, Commerce Systems, Data Analytics and Personalization, Product recommendations, Promotion optimization, Marketing automation

Poll: fashion market, which of these is correct?

A

Average items in one wardrobe at any one point in time is approx. 50; utilization per item (taking into account the whole wardrobe) is 50

B

Up to 9% of all textile products put on the market in Europe are deliberately destroyed (unsold and returned items)

C

Circular business models (resale, rental, repair) already represent over 10% of the total fashion market

D

Luxury items have a lower utilization than mass/mid-price items due to their exclusive quality and infrequent usage context

Poll: fashion market, which of these is correct?

Correct answer(s) provided during the lecture

Brands are translating waste into a new rule

Substantial questions for the supply chain, commerce, customer relationship, marketing, recommendations, promotions etc.



4-9% of all textile products put on the market in Europe are destroyed before use, amounting up to 594,000 tonnes of textiles destroyed each year (mostly combusted)

EU published on March 2022 a proposal for 'Ecodesign for Sustainable Products' in which the deliberate destruction of unsold and returned goods is prohibited with the aim of improving, among other things, the circularity of products.

Economies of scale and scope

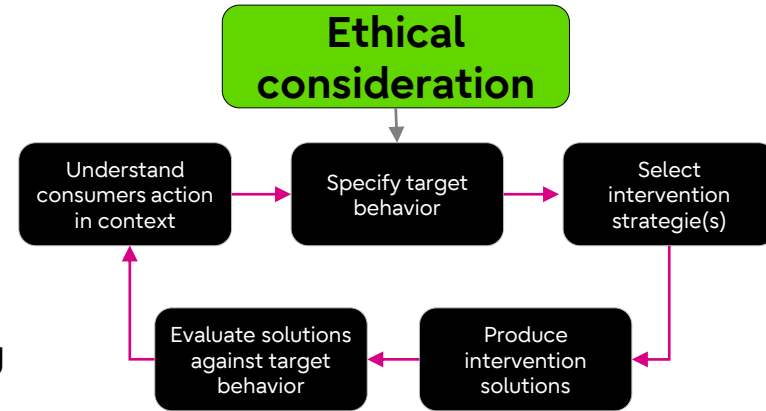


From 'design and search materials' to 'materials in stock trigger design'
Produce less than demand
Personalized discounts/promotions



Circular economy
Re-commerce

- Sustainable consumption requires a behavioral change
- Help consumers meet their everyday consumption needs in a sustainable way (learn new ways of experiencing)
 - Drive consumer awareness of sustainability
 - Drive sustainable lifestyle choices
 - Drive new immaterial supply of consumption
 - Develop personal identity and social connections
 - Calculate impacts and target lifestyle changes (in areas that produce most harm)
 - Enable service systems that support longevity/recycling
 - Provide positive feedback on “good deeds”



Engage, lead, encourage or focus consumers' attention on sustainability

Sustainable

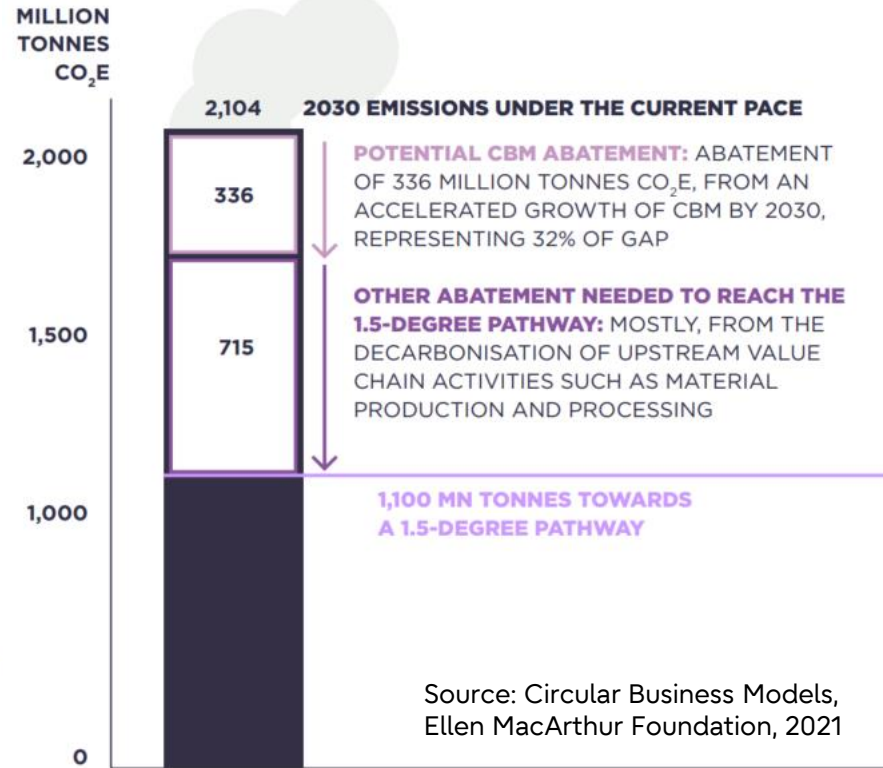
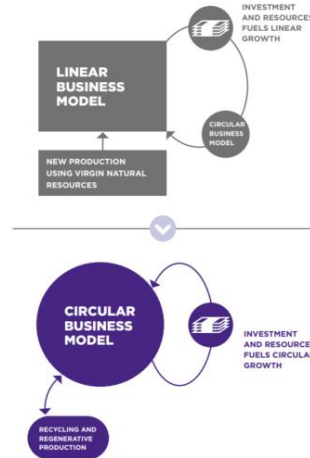
Environmentally friendly

Responsible

Consumption

Potential of circular business models

- If resale, rental, repair and remaking reach 23% market share in 2030, this could lead to CO₂e reduction for the fashion industry of up to 16%
 - Achieving a higher number of uses with fewer products, displaces the need for new production
- Front-end impacts to business processes and enterprise applications
 - Performance indicators
 - Customer incentives
 - Commerce systems
 - Marketing systems



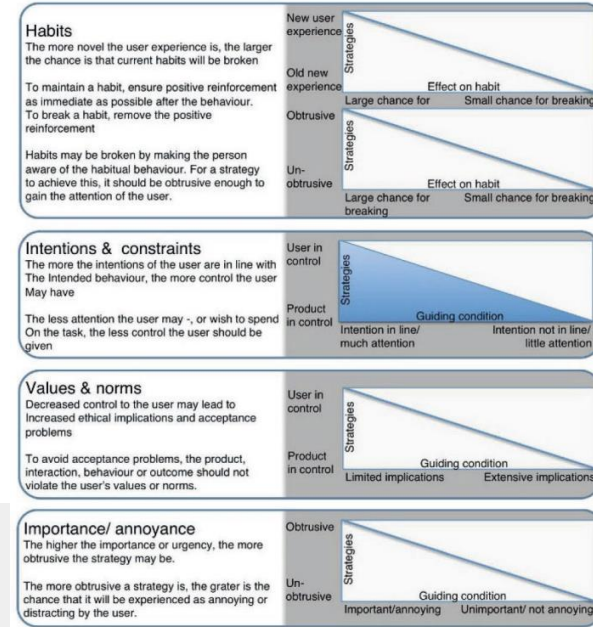
Sustainability impact to CRM/Commerce

- Behavioral change = use of interventions designed for the purpose of supporting decisions and actions that lead to short term and long-term changes that benefit the individual and society
- Precedent interventions
 - Commitment / Goal setting / Informational / Structural
- Consequence interventions
 - Rewards / Feedback

As-is: consumers' positive attitudes towards responsible consumption and, on other hand, despite positivity of attitudes, low level of activity

How to bring about change in consumers' decision-making and behavior?

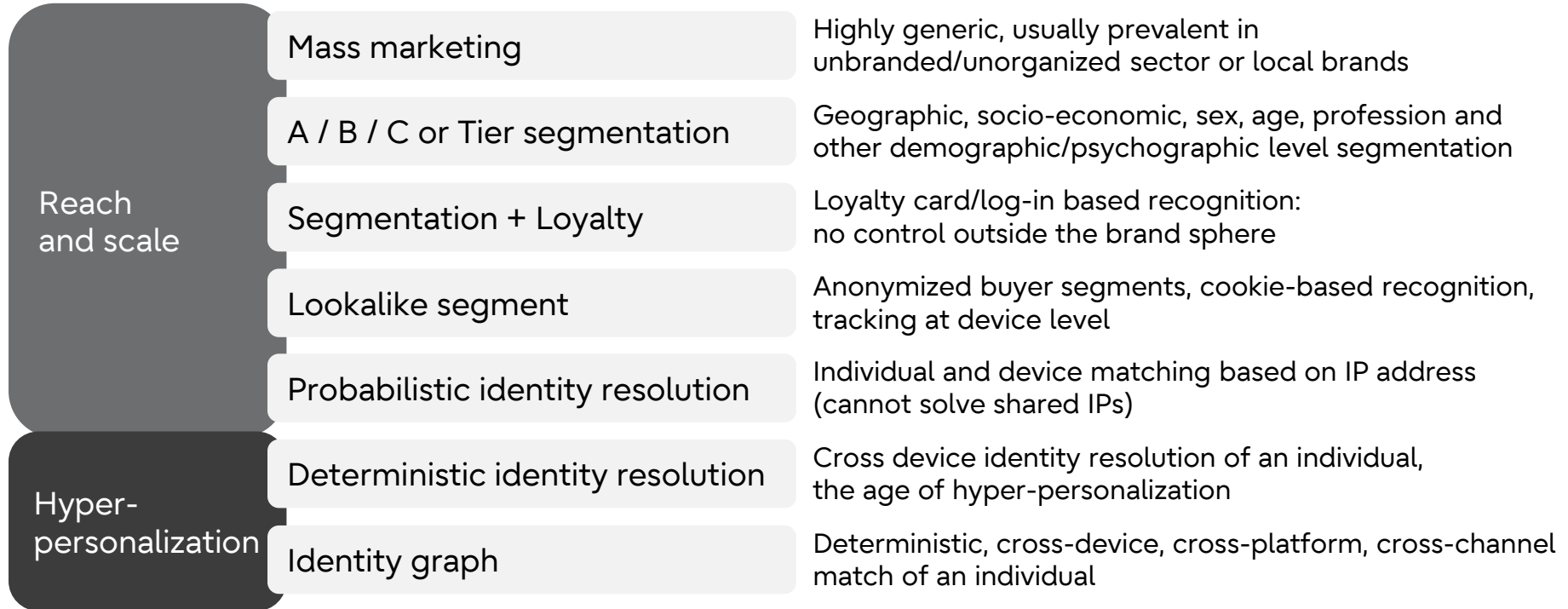
Hypothesis: consumers lack services to implement environmentally sustainable everyday habits and consumption patterns



- Engage, lead, encourage or focus consumers' attention on environmental savings
 - Cognitive, thinking and attitudes interventions through information sharing (awareness) and intangible feedback (rewards) to consumers' decisions and choices
 - Interventions are activities designed to change behaviors
 - Most effective interventions target many levels simultaneously
- Intervention functions
 - Use rules to reduce the opportunity to engage in a behavior (or to increase behavior by reducing opportunity to engage in competing behaviors; restrictions)
 - Increasing knowledge or understanding (education)
 - Communicate to induce positive/negative feelings to stimulate action (persuasion)
 - Creating an expectation of reward (incentivization)
 - Creating an expectation of punishment or cost (coercion)
 - Imparting skills (training)
 - Increasing means or reducing barriers to increase opportunity (enablement)
 - Provide an example for people to aspire to or emulate (modeling)
 - Built goal-based playfulness and gamifications (engagement)



Towards identity resolution



Terrestrial identity: home address, work address, home phone number, ...
Device identity: IP/other identification data of various devices associated with individual
Digital identity: email IDs, log-in credentials, social profiles, blogs, website registrations etc.
Commerce identity: credit card numbers, purchase history, shopping locations, ...

There is usually no doubt about who the individual is

- Circular economy related solutions
 - Move from resource-linked growth to business-based growth
- Generate longitudinal, shared and multiple cycle product flows
 - Service systems that support consumer interaction with these diverse cycles
- Service solutions to manage resources in the market rather than the typical production management – systemic approaches to the use phase of products
 - Help consumers to make the most of products
 - Help trade between consumers (sharing platforms)
 - Serve in different ways to make unseasoned products available (product as a service)
 - Provide buy-back services and sell functionality as a service instead of a product

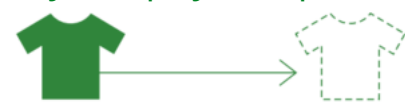
More use per product



More users per product



Beyond physical products



Beyond ERP > Commerce



SUSTAINABILITY / BUSINESS What to Watch: France Bans Destruction of Unsold Clothes and Adds Eco Score

These are among measures that came into effect on Jan. 1 as part of the planned road map from the anti-waste law voted in 2020.

By LIZ TEMPLETON | JANUARY 5, 2022, 10:00AM



Too good to go: France bans destroying unsold non-food merchandise. ESTELLE FOLLA/AGENCY/GETTY IMAGES



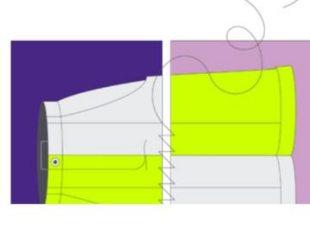
RESALE

This includes peer-to-peer sale of second-hand items (online and offline), third-party marketplaces (online and offline), and own-brand re-commerce and take-back (online and offline)



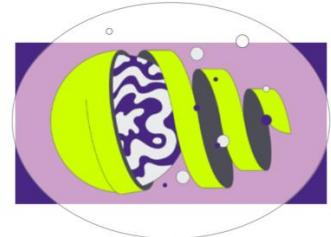
RENTAL

This includes one-off peer-to-peer rentals by private owners, as well as large-scale rental and subscription models by multi-brand platforms or individual brands



REPAIR

This is the operation by which a faulty or broken product or component is returned back to a usable state



REMAKING

This is the operation by which a product is created from existing products or components. This operation can include disassembling, re-dyeing, and repurposing

How to organize sustainable action and re-commerce in a successful way is an open question for both retailers and brands today

Short-term rental business in 2024?

Case exercise: car rental company FUJITSU

Think about it yourself...
What would you do to make it work?

Not just work but provide customers with a quality service, efficiently, with several market differentiating elements that beat Avis, Sixt, Budget, Hertz, National,...

Focus on understanding the experience that the customer wants delivered.

VALUE PROPOSITION TEMPLATE

Unlike our _____ helps who want to _____ by _____ and _____

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From value stream to processes & interactions FUJITSU

Core process

Input: Customer Request to Rent Car → **Rent Cars** → Output: Car Returned and Paid For

Several support processes

- HQ and Operating Company: ROI, Policies Information on Reservations & Customers
- City & Provincial Agencies: Business Licenses, Taxes & Fees
- Owners / Managers of Local Area: Capital, Income
- Acquire & Dispose of Car: Requests for new cars, Cars available for Use, Cars to be disposed of
- Renters: Request for car, Rented car, Payment
- Credit Card Company (Bus. Partner): Request for credit approval, Approval
- Employees: Salaries, Skills & Knowledge

Harvard Business Review THE EVOLUTION OF DESIGN THINKING

24 Copyright 2019 FUJITSU

In the end you would be trying to solve these problems through the design and creation, and of business apps.

Car rental exercise in 2019:
How would you improve short-term rental processes and customer interactions using new digital innovations over the last 5 years to drive sustainability, customer experience and business transformation?



Summary

- Digital technologies increase performance of traditional enterprise applications by modifying and extending ways and means of operating a business
- Constant improvement in “numbers” is good but doing things better is insufficient when markets shift
- Successful environmental- and sustainability-driven ideas always have a good financial model
- At the heart of digital transformation strategy lies the role of enterprise applications

Cobol is not dead: hundreds of billions of lines of code is running on production systems in daily use (65% of all software)





You hopefully know what types of enterprise applications organizations put in place to operate and improve performance

Business processes that enterprise apps assist
Continuous need to evolve as market changes
Adopting and integrating new technologies
Fundamentals of business transformation
Sustainability-driven changes

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in the world.
Aalto-yliopisto
Aalto-universitetet
Aalto University

Thank You!
KIITOS!

Hauskaa Wappua!

