SCOPE AND METHODOLOGY

JANUARY 2019

APPANION

TERMINOLOGY AND DEFINITIONS

Definition of key figures:

Gross Impact:
The absolute share of revenue that is directly influenced by the use of artificial intelligence. The effects of revenue growth and efficiency gains, adjusted for implementation costs and substitution effects, are taken into account.

Net Impact:
The absolute share of revenue normalized by macroeconomic effects that is influenced by the use of artificial intelligence.

Term classification of artificial intelligence:

There is no established definition of AI, which is why we follow a simplified formula to define artificial intelligence:

specific question + **suitable data** + **algorithmic model** = Probability

We understand the calculated probability for a previously specified decision on a suitable database that improves or automates human action as artificial intelligence.

Out-of-scope:

- The figures *do not* show the market size or the revenues generated by providers of AI software.
- Political or regulatory interventions in the use of data and application development or social policy measures in the forecast period are *not taken into account.*
- Public security and defense are *not* considered as an industry.

Data scientific context:

We differentiate between already established analytical methods and the use of modern method sets based on neural networks:

Advanced Analytics: Classification, Regression, Clustering, Markov Process, Monte Carlo, Dimensionality Reduction, Complex Optimization, Ensemble Learning / Decision Trees

Machine Learning: Feed-forward Neural Networks, Recurring Neural Networks, Convolutional Neural Networks, Reinforcement Learning, Generative Adversarial Neural Networks

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TOP-DOWN APPROACH TO DERIVE THE AI IMPACT

1. Identification of AI use cases by main enterprise functions
2. Status analysis and forecast of industry revenues in Germany across 40 different industries
3. Evaluation of the relevance of individual enterprise functions for the value creation of the respective industries
4. Evaluation of the impact of use cases in the respective enterprise functions
5. Assignment of the relevant data-scientific methods
6. Projection of the impact of individual use cases per industry on the overall industry performance until 2030

USE CASE OVERVIEW BY ENTERPRISE FUNCTION

Marketing and sales

Customer acquisition & lead generation
- Social media channel management
- Market research & behavior analytics
- Automated social & PR analytics
- Content creation

Pricing and marketing budget allocation
- Dynamic pricing optimization
- Marketing spent optimization
- Sales forecasting

Customer value optimization
- Retargeting & personalization
- Product recommendation engine
- Context aware marketing
- Churn reduction
- Anticipatory CRM and upselling

Customer service management
- Chatbots and intelligent routing
- Biometrical authentication

Supply chain and production

Yield optimization
- Predictive maintenance
- Yield simulation and optimization
- Energy and throughput efficiency
- Intelligent quality control
- Procurement and spend analytics

Logistics network optimization
- Supply chain optimization
- Autonomous transportation
- Smart vehicle routing and fleet management

Warehouse optimization
- Demand forecasting
- Inventory optimization

HR

Analytics-driven hiring and retention
- Analytics-driven hiring
- HR retention management

HR Performance and safety management
- Performance and safety management
- Building management and security

Finance

Smart expenditure and accounting
- Expense and income reporting
- Analytics-driven accounting

Smart investing
- Robo advisory

Risk management

Risk modeling
- Regulatory compliance & SLAs
- Risk scoring and valuation

Fraud and debt analytics
- Fraud detection
- Billing and debt collection

Product development

Product Engineering
- Product development cycle optimization
- Product feature optimization

Operations

Task automation
- Robotic Process Automation (RPA)
- Autonomous cybersecurity systems

Task augmentation
- Monitoring and assisted decision-making

IT & administration

Workforce productivity and efficiency
- Collaborative robots
- Knowledge management
- Translation, transcription, protocolling
- Contextual search and data generation

Data Management
- Data cleaning & validation
- Data labeling

INDUSTRIES COVERED IN THIS ANALYSIS

Sector	Industry
Agriculture	Agriculture
Mining	Mining
Manufacturing	Manufacture of Consumer Goods
	Other manufacturing
	Manufacture of Basic Materials and Energy
	Manufacture of Chemicals
	Manufacture of Pharmaceutical products
	Manufacture of Advanced Electronics
	Manufacture of Machinery and equipment
	Manufacture of Automotives
Utilities	Utilities
Construction	Construction
Trade	Vehicle Trade
	Wholesale
	Retail
Transportation	Freight Transportation
	Passenger Transportation
	Warehousing
	Postal and last-mile delivery
Accomodation & food services	Accomodation & food services

Sector	Industry
Information Services	Media, Publishing, Broadcasting
	Telecommunications
	IT Services & Consultancy
Financial Services	Banking and Trading
	Insurance
Real Estate	Real Estate
Professional Services	Legal, Accounting, Consulting
	Architects, Engineering, R&D
	Advertising
	Other professional services
Administrative Services	Rental Services
	HR
	Travel
	Private Security
	Facility Mgmt
	Business Support
	Personal Public and Social Services
Education	Education
Healthcare	Healthcare System and Services
Entertainment and Culture	Entertainment and Culture

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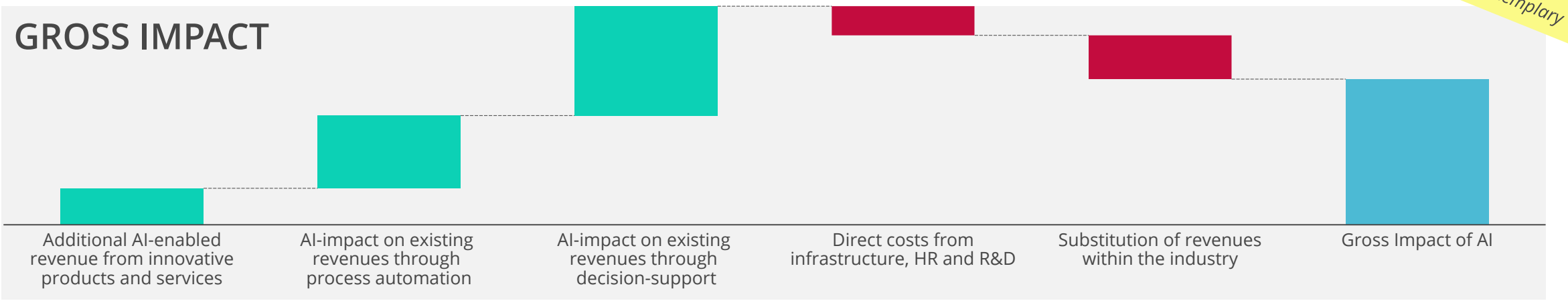
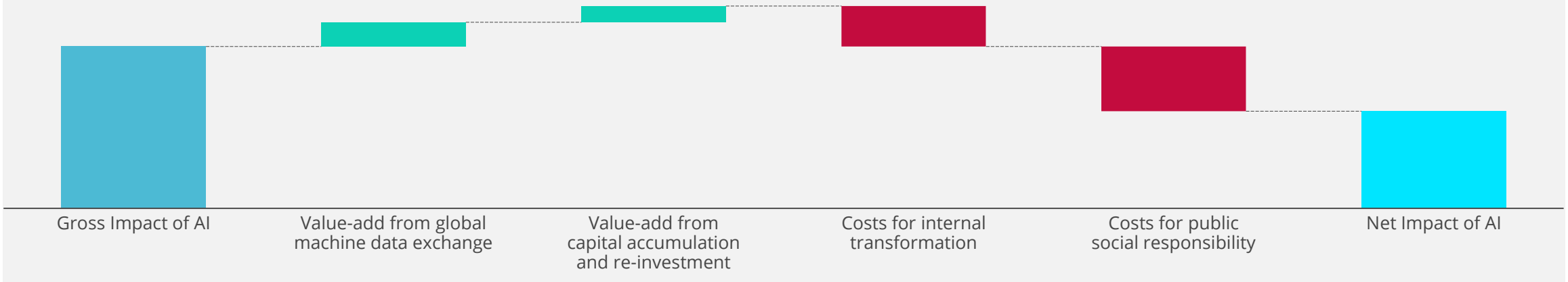
DERIVATION OF GROSS AND NET IMPACT

exemplary

GROSS IMPACT



NET IMPACT



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EXPLANATION: GROSS IMPACT OF AI

What is the Gross Impact?

The Gross Impact of artificial intelligence is a monetary indicator and describes the share of revenue that is directly or indirectly influenced by the use of artificial intelligence.

First of all, the added value gains generated by the use of technology are added up. This includes the additional revenue from products and services that are offered based on AI or structurally enabled (e.g. software, robotics, automated brokerage services).

Further added value gains result from the increase in output efficiency through artificial intelligence, i.e. process automation and increased employee effectiveness through AI-supported decisions are measured in proportion to the existing revenues.

This added value gain is adjusted for direct costs related to infrastructure setup (data management, processing power, cloud), the acquisition and training of AI experts for project implementation, and expenditure on research and development.

Furthermore, direct reallocation effects within an industry are deducted that arise from shifts in market share or substitution effects caused by the technological change.

Calculation of the Gross Impact

	Gain in added value from AI product and service innovations
+	Gain in added value from AI process automation
+	Gain in added value from AI decision support
-	Costs for Infrastructure, HR and research & development
-	Reallocated revenue within the industry
=	**Gross Impact of AI** (as share of the annual industry revenue)* *

*Industry revenue includes tax-adjusted revenue from deliveries of goods and services by enterprises with an annual turnover of more than €17,500 according to the official tax statistics of the Federal Statistical Office

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EXPLANATION: NET IMPACT OF AI

What is the Net Impact?

The Net Impact of artificial intelligence measures not only the direct effect of the technology on the added value of an industry, but also includes positive and negative macroeconomic effects.

Based on the previously calculated Gross Impact, added value gains from global machine data exchange are included (cross-border trade, frictionless data exchange within value chains, removal of language barriers via speech recognition and automated translation).

In addition, added value gains from capital accumulation and re-investment in AI are taken into account, for example in the form of corporate assets, venture capital, underlying infrastructure optimization, etc.

In contrast, costs incurred for internal transformation processes (restructuring, employee acquisition and training, consulting) based on size and degree of digitization are deducted.

Social responsibility costs (severance payments, long-term social security, retraining or transfer companies) are also deducted. The net impact provides information on the overall profitability from the use of AI.

Calculation of the Net Impact

	Gross Impact of AI
+	Gain in added value from global machine data exchange
+	Gain in added value from capital accumulation and re-investment
-	Costs for transformation processes
-	Costs for public social responsibility
=	**Net Impact of AI** (as share of the annual industry revenue)*

*Industry revenue includes tax-adjusted revenue from deliveries of goods and services by enterprises with an annual turnover of more than €17,500 according to the official tax statistics of the Federal Statistical Office

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EXTERNAL SOURCES AND INDICATORS

The impact of AI on the economy is measured on the basis of total annual revenues (excluding taxes) from supplies and services across all industries. This is important in order to break down the effects in detail on the individual stages of the value chain. For this reason, gross value added and gross domestic product are less suitable as economic indicators which are already adjusted for intermediate consumption.

The data basis comes from the official VAT statistics of the Federal Statistical Office; the revenue forecast up to 2030 was made on basis of macroeconomic forecasts of the Federal Statistical Office and publicly available industry forecasts made by Statista.
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The sector-specific added value and cost ratios are derived from a comprehensive data model, based on studies by the McKinsey Global Institute and further developed and evaluated by economic experts and with the use of numerous statistical market indicators.

The sector-specific market indicators include:

- Market growth dynamics[1]
- Investment capabilities[1]
- Number of employees[1]
- Digital Innovation Readiness[1]
- Proportion of probability-related decision-making processes[2]
- Availability of processable data[2]
- Share of current process automation[2]

The indexed values for the sectors as a starting point for the modelling can be seen in the adjacent table.

Industries	Market growth dynamics	Investment capabilities	Number of employees	Digital Innovation Readiness	Share of probablity-related decision-making processes	Availablitity of processable data	Degree of current process automation
Agriculture	0.16	0.24	0.17	0.19	1.11	0.66	0.74
Mining	2.05	0.10	0.06	0.31	0.89	0.40	0.22
Manufacture of Consumer Goods	0.00	1.79	1.73	1.35	1.33	1.04	1.33
Other manufacturing	0.81	0.95	0.88	0.73	1.25	0.91	0.89
Manufacture of Basic Materials & Energy	1.30	2.48	1.81	0.85	1.18	0.62	0.66
Manufacture of Chemicals	0.08	1.65	0.19	1.08	1.22	0.71	1.11
Manufacture of Pharmaceutical Products	2.10	0.57	0.39	1.20	0.97	0.91	1.25
Manufacture of Advanced Electronics	1.23	1.44	1.04	4.01	1.42	1.32	1.55
Manufacture of Machinery & Equipment	0.57	1.46	1.67	2.28	1.66	0.90	1.60
Manufacture of Automotives	2.75	3.74	1.23	3.82	1.72	1.05	1.77
Utilities	0.83	2.02	0.31	0.46	1.15	0.87	1.05
Construcation	1.51	1.71	2.10	0.35	0.69	0.61	0.60
Vehicle Trade	2.70	0.50	0.87	0.12	0.90	0.70	0.40
Wholesale	0.60	1.16	2.06	0.08	1.13	0.80	0.55
Retail	1.41	1.94	3.55	0.04	1.81	1.62	0.66
Freight Transportation	0.15	0.27	0.36	0.77	1.48	1.10	0.69
Passegner Transportation	0.92	0.18	0.71	0.93	1.41	1.51	0.78
Warehousing	1.28	0.59	0.84	0.85	1.69	1.17	1.00
Postal and last-mile Delivery	1.22	0.16	0.53	0.85	1.57	1.43	0.51
Accomodation and Food Services	2.55	0.52	1.24	0.23	0.95	1.24	0.42
Media, Publishing, Broadcasting	0.40	0.31	0.35	0.97	0.98	1.90	1.39
Telekommunications	0.27	0.35	0.12	2.74	1.18	1.30	1.61
IT Services & Consulting	3.28	0.63	0.88	2.70	0.69	1.69	1.42
Banking & Trading	0.77	0.72	0.99	0.27	1.04	1.31	1.34
Insurance	2.03	0.12	0.23	0.31	1.20	1.35	1.44
Real Estate	1.46	0.93	0.34	0.42	0.91	0.72	1.07
Legal, Accounting, Consulting	0.81	0.75	1.27	0.57	0.83	0.50	0.89
Architects, Engineering, R&D	1.87	0.48	0.92	0.52	0.56	0.76	0.72
Advertising	2.19	0.20	0.23	0.77	1.39	2.22	1.99
Other Professional Services	3.83	0.10	0.15	0.39	0.83	0.81	0.43
Rental Services	2.15	0.26	0.12	0.44	1.19	1.01	1.09
HR	2.96	0.18	1.17	0.50	0.70	0.86	1.27
Travel	0.85	0.06	0.11	1.16	1.14	1.82	1.74
Private Security	4.04	0.06	0.26	0.08	0.42	0.30	0.21
Facility Management	3.60	0.24	1.29	0.15	0.97	0.59	0.53
Business Support	1.63	0.22	0.55	0.39	1.05	0.94	1.27
Personal Public and Social Services	0.30	0.28	1.92	0.08	0.77	0.64	0.49
Education	2.89	0.08	1.18	0.27	0.37	0.71	0.45
Healthcare Systems and Services	2.49	0.64	5.85	0.66	0.69	1.08	0.91
Entertainment and Culture	2.09	0.26	0.34	0.46	0.56	1.27	1.35

1) Source: Data basis Federal Statistical Office, Statista industry forecasts, ZEW
2) expert assessment

FORECASTING METHODS

How was the development projected?

On the basis of 46 use cases in 40 different industries in Germany, initial values for the Gross and Net Impact of each individual use case were modelled and projected for the German market over the period up to 2030.

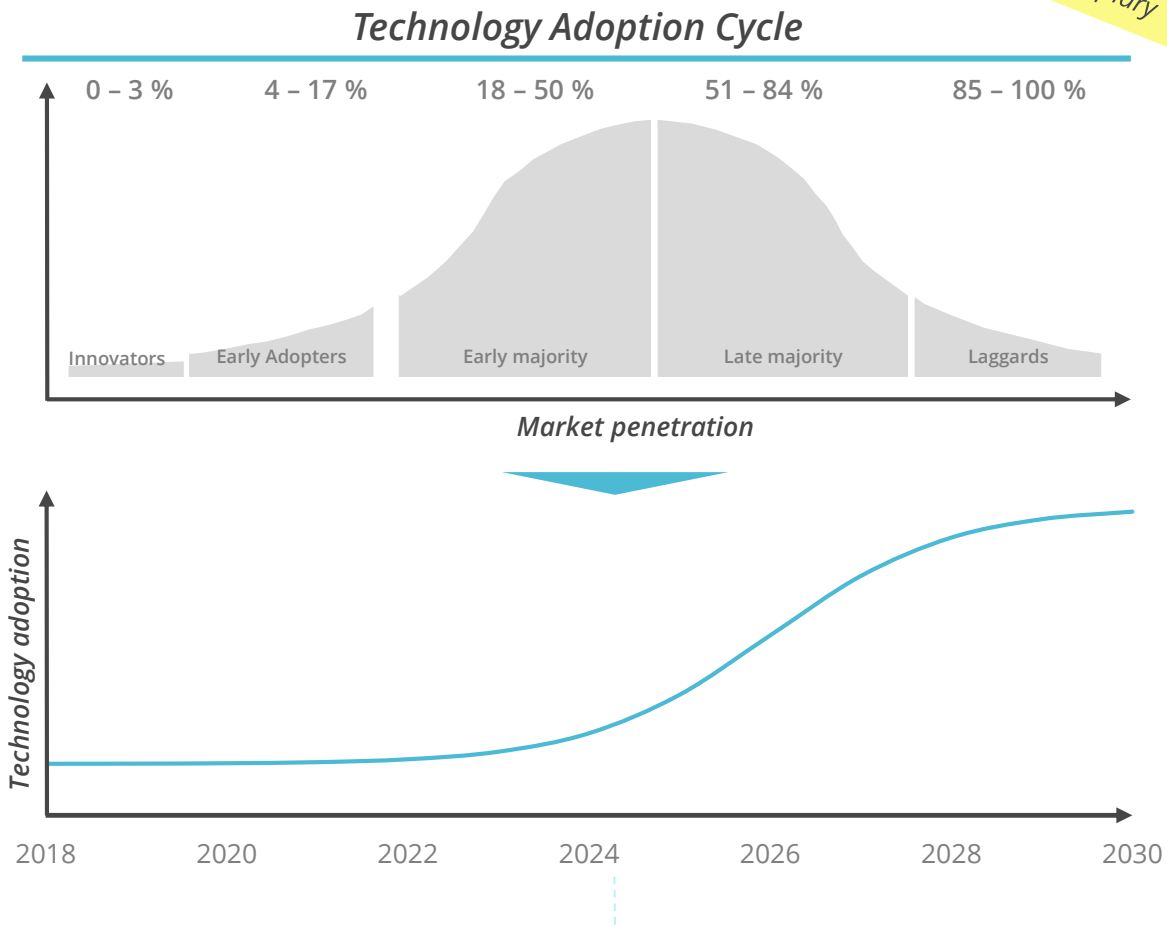
The extrapolation is based on the one hand on the initial revenues of the respective industries, changes in the applied market indicators over time, and on the other hand on a technology adaptation factor that was additionally modelled at the use case level.

The adaptation factor follows the basic theory of the "Technology Adoption Cycle" from innovation research and maps an s-curve progression. This reflects the successive adaptation of innovators, early adopters, early and late mass-markets and technology laggards.

The mathematical basis for this is a parameter-based, logistic regression model, which can be used to map industry and use case specific features and to represent an independent technology penetration.

In this context, use cases that have no or negligible economic significance in certain industries were excluded..

exemplary



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DO YOU HAVE ANY FURTHER QUESTIONS?

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WE APPRECIATE YOUR CONTACT!