Collaborative Research and Innovation in Europe (esp. Germany)

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I. Overview of Cooperation between Higher Education and Industry in Germany

Types of Higher Education in Germany

University/Technical
University

University of
Applied Sciences (FH)

University of Cooperative
Education (Dual System)

School of Education (PH)

Theologische Hochschule

Fachhochschulen für öffentliche
Verwaltung (FHöV) and
DHV Speyer

University

- Offer almost all study programs
- Offer PhD programs
- Focuses on research, theories, and sciences
- Learning in large classes
- Minimum student supervision
- Professors have experiences in research

University of Applied Sciences

- Do not offer medicine, teacher education, law, and natural sciences
- No PhD programs, except in cooperation with universities
- Focuses on the applications of sciences
- Learning in smaller classes
- Intensive student supervision
- Professors have experiences in industry

Bidirectional Relationship between Industry and Higher Education

- Recruitment of professors
- Research contracts and funding
- Visiting lecturers
- Accreditation

- Internships
- Research transfer
- Consulting
- Supply of skilled labors

Comparison between Indonesian and German Lecturer

Qualification	S2 or S3	++ S3 ++
Linearity vs. transdisciplinary	Linearity is important	Transdisciplinary is strength
Decision maker in recruitment	Policy makers	Users: colleagues, industry, students, ...
Authority	According to rules from government/policy makers	<i>Freedom of teaching and research</i>
Access to resources	Resources are managed by „home base“, e.g. study program, faculty	Resources are managed by the professor
Teaching load	12 SKS?	9/10 SWS (Uni), 18 SWS (FH/UAS)
Performance evaluation	Standardized (nationally)	Based on agreement by considering strengths and weaknesses
Career mobility: industry - academia	Generally not possible	Encouraged

Typical Organization Structure in Universities

II. Research Landscape in Germany

Research in Germany

RESEARCHER RANKINGS

Germany has the highest number of researchers working in science and technology industries and academia in the European Union.

THE GERMAN GOVERNMENT LOVES SCIENCE

In 2016, researchers working across the natural sciences received more funding than those in other academic disciplines.

GERMAN R&D UNDER THE MICROSCOPE

A self-ranked assessment of how public and private research organizations in Germany are funded and their research priorities.

(Boychev 2019)

MAX PLANCK GESELLSCHAFT

- Focuses on basic research
- 86 research institutes and facilities (5 institutes outside Germany)
- Over 23,000 employees
- More than half of the researchers come from outside Germany
- Annual budget: approx. 2.4 billion euros (2018)
- Research area: Natural sciences, Life sciences, Social sciences and the humanities

Individual figures do not add up to 100% due to rounding

MPI of Plasma Physics

MPI of Quantum Optics

Fraunhofer

- Focuses on applied research
- Largest research organization in Europe
- Total of 72 and research units
- More than 26,600 employees institutes and research facilities
- Annual budget: 2.6 billion euros (2018)
- 612 patent applications (2018)
- Focuses: Health and environment , Security and protection, Communication and knowledge , Mobility and transport , Energy and resources , Production and supply of services

Fraunhofer IAO

Image: NZZ

Federal institutions

- Supports the ministry's activities and provide the necessary scientific basis for government measures.
- 40 federal R&D institutions
- 18,600 staff, including more than 9,400 R&D personnel
- Internal expenditure: 2.9 billion euros (2017)
- Research focuses:
 - The impact of modern technologies
 - Health and nutrition
 - Mobility and urban development
 - Environment, energy and climate protection
 - Changed working and living conditions

■ Public sector
■ Revenues from commercial activity
■ Others

ROBERT KOCH INSTITUT

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Umwelt
Bundesamt

BAM

Bundesanstalt für
Materialforschung
und -prüfung

d.i.e

Deutsches Institut für
Entwicklungspolitik

German Development
Institute

Länder (state) institution

- Research institutes that support state research activities.
- Over 160 research organisations
- 6,100 staff, including more than 2,600 R&D personnel; among them 1,300 researchers
- Internal expenditure: 520 million euros in total, including 220 million euros for R&D (2017)

Image: DFKI

Companies & industrial research

- Accounts for $> 2/3$ of all R&D funding in Germany
- Work closely with universities, universities of applied sciences and non-university research institutes
- Umbrella: Federation of German Industries (BDI)
- Approx. 451,000 R&D personnel (2018), including 236,000 researchers (2016)
- Annual budget for R&D: approx. 72.1 billion euros (2018)

Boehringer Ingelheim

Companies with the highest R&D spending in Germany in 2017/18 (in billion euros)

Source: EU R&D Scoreboard 2018

Cooperation between industry and research

- Contract research for industry carried out by universities and non-university research institutions
- Joint staffing and funding of research projects
- Industry-funded research groups
- Donations and sponsorship for specific R&D institutes
- Establishment of endowed professorships by companies
- Jointly funded research structures or institutes
- New collaborative models in networks, clusters or public-private partnerships/research campuses

Industrial research associations

- Collaboration between Research-based companies and independent private research institutes to carry out industrial research especially for the SME sector.
- Example:
 - German Federation of Industrial Research Associations (AiF)
 - Zuse Association: non-profit association of independent industrial research institutes.

ZUSE-GEMEINSCHAFT
FORSCHUNG, DIE ANKOMMT.

Bioreactor @Zuse

AiF project „PodCopter“

III.

Examples of Collaborative Research and Innovation Projects

ecobalance

- Statistical analysis and machine learning approach to identify energy profile for each industrial machine and process
- Forecasting of costs and power consumption and costs of customized product
- Optimization model for production planning and control with power peak avoidance, having lowest costs, and on-time lead time
- Cloud-edge architecture
- Applied in a metal processing SME
- Budget: € 600 000

Data management for Smart Energy Systems

- Linked-data/ knowledge graph to integrate heterogeneous datasources on semantic level
- Machine learning and time series analysis to forecast energy generation and consumption
- Energy simulation to estimate energy and heating demand
- Hyper heuristic optimization for optimal renewable energy infrastructure planning
- Budget: € 4 054 239

KnoholEM

Knowledge-based energy management for public buildings
through holistic information modeling and 3D visualization

- Ontology based semantic information model which fuzzy reasoning capability
- Machine learning to identify energy usage pattern, anomalies, and waste
- Heuristic approach to recommend actions to achieve energy efficiency targets
- Collaborations of 13 organizations (universities, industry, municipalities) from Germany, Ireland, UK, Italy, Netherlands, Spain
- Budget € 4 468 165

- Changing the power demand side to meet the availability of renewable energy
- Machine learning for forecasting of power consumption and generation
- Semantic middleware for realtime communication between electricity provider and consumer
- Dynamic price estimation
- 3D simulation for manufacturing planning and renewable energy integration
- Budget € 2 000 000

Thank You

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