Gotong Royong Membumikan Inovasi Teknologi ala Jerman

HENDRO WICAKSONO

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I. Introduction to Innovation

What is Innovation?

Innovation 4P

Where do innovations come from?

Closed vs. Open innovation

Image (Tidd and Bessant 2009)

The German Social Market Economy

- Free market + social-oriented policies = welfare state
- A middle way between liberalism and capitalism
- Inspiration: ordoliberalism + social democracy + Christian ethics

MITTELSTAND COMPANIES AS SPEARHEAD OF GERMANY'S SUCCESS IN EXPORTS

Annual revenues	Number of companies ¹⁾	Share in German ex
Large companies > 1.000 m €	501 (0,02 %)	31,69 %
Mid-sized enterprises 250 – 1.000 m €	1.806 (0,06 %)	36,88 %
100 – 250 m €	3.483 (0,11 %)	
50 – 100 m €	5.508 (0,17 %)	
SME segment < 50 m €	3.239.021 (99,65 %)	31,43 %

MANAGEMENT MODEL "MADE IN GERMANY"

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¹⁾ Source: German VAT statistics 2007
²⁾ Verarbeitendes Gewerbe nach WZ2008: 11, ohne Land- und Forstwirtschaft, Fischerei und Pflanzung, Bebauung und Gewinnung von Steinen und Erden, Handel, Energie- und Wasserversorgung, Finanzdienstleistungen, etc.
 Source: Own calculations and Top 500 Unternehmen in Deutschland 2005 © DIE WELT.de 2006; Statistisches Jahrbuch 2008

Source: Konrad <Adenauer Stiftung

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Example of ongoing innovations made in Germany

Daimler meets Avatar

Tomatoes in space (DLR)

Nanorobot in the Body (Max Planck)

Digital twin, human-robot collabs

Personalized meta products

Images: deutschland.de

II. Research and Innovation 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.

(Boytshev 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

- 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

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

Bioreactor @Zuse

AIF project „PodCopter“

III.

Implementation of Triple-Helix Innovation in Germany

Triple Helix Innovation Models

Model 1

Model 2

Model 3

(Etzkowitz & Leydesdorff 2000)

Triple Helix Implementation in Germany

1: University Spin-Off

eXIST
Existenzgründungen
aus der Wissenschaft

- Startup founder scholarship
- Grants for transfer from research to start-up
- Support of start-up culture in university

Example of
successful startups

OPENEXPERIENCE

SHAREMAC

vilisto
einfach Wohlfühlklima

NosoEx[®]
powered by GWA Hygiene

Transformation of University Program

Image: HS Karlsruhe

- Integration of startup programs in university's curricula
- Startup activities substitutes courses credits

2: Open Research and Innovation Projects

Project Examples

3: Strategic Alliances and Innovation Clusters

4: Collaborative innovation labs: Industry 4.0 implementations

- Small and Medium Enterprises
- University Research
- Research Outside University
- Large Companies

Testbeds

Source: Plattform Industrie 4.0

Triple Helix Model 3 Requires Transformation of All Parties

From teaching to **research and innovation** university

From closed to **open innovation**, from one-man show to **ecosystem of global village**

From top-down to **bottom-up** policy making

Indonesia: Quintuple Helix?

(based on Carayannis et al 2012)

IV. Examples of Research and Innovation Project Collaborations

Types of Projects

Project Example

Bundesministerium
für Wirtschaft
und Technologie

- Objective: Development of Demand Response System for manufacturing
 - Forecast models for power consumption and decentralized energy generation systems.
 - Dynamic electricity price models
 - Semantic middleware for data communication between energy producer and consumer
 - Integration of price signals into production planning for efficient use of resources.
 - Transfer of planning data from the industry to the energy producer / network operator, which includes the implementation of further demand-response readiness analyzes.

ecobalance

- Digital twin containing **machine learning** to identify energy consumption profile for each industrial machine and process
- Forecasting of costs and power consumption 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

Workpackage Dependencies

Project Organization Structure

IP Management

- **Background IP:** all Intellectual Properties belonging to or controlled by either Party,
 - (i) developed, conceived, obtained or acquired prior to the agreement/ project or
 - (ii) developed, conceived, obtained or acquired independently of the agreement/project or not as part of the approved project statement.
- **Foreground IP:** means any Intellectual Property arising from the project;

Background IP Examples

4.1.1.5 Relevant publications, products, services, and achievements

Publications

1. McGinn, K.; Weise, M.; Wicaksono, H. (2016): *Towards a Shared Use Case Repository to support Building Information Modelling in the Energy Efficient Building domain*. In CIB W78 Conference, Queensland University of Technology, Brisbane, Australia.
2. Wicaksono, H.; Krahtova, P.; Häfner, P.; Rogalski, S. (2015): *Methodology to Develop Ontological Building Information Model for Energy Management System in Building Information Phase*, Knowledge Discovery, Knowledge Engineering and Knowledge Management Communications in Computer and Information Science, Springer, Volume 454, 2015, pp 168-181
3. Wicaksono, H.; Rogalski, S.; Jost, F.; Ovtcharova, J. (2014): *Energy Efficiency Evaluation and Optimization in Manufacturing through Ontology Represented Knowledge Base*, in: International Journal Intelligent Systems in Accounting, Finance and Management, John Wiley and Sons, 2014, pp. 1099-1174
4. Wicaksono, H.; Dobrev, P.(Krahtova); Häfner, P.; Rogalski, S. (2013): *Ontology Development towards Expressive and Reasoning-enabled Building Information Model for an Intelligent Energy Management System*, 5th International Conference Knowledge Engineering and Ontology Development, 19-22 September 2013, Vilamoura, Algarve, Portugal (**Nomination for Best Paper Award**)
5. Häfner, P.; Häfner, V.; Wicaksono, H.; Ovtcharova, J. (2013): *Semi-automated Ontology Population from Building Construction Drawings*, 5th International Conference Knowledge Engineering and Ontology Development, 19-22 September 2013, Vilamoura, Algarve, Portugal.

Product and Services

1. **ontoCAD** is a tool to generate instances and to populate ontologies by interpreting 2D sketches and extracting their semantic which was initially developed in KnoHolEM project. ontoCAD allows the user to decide the corresponding semantics any geometrical shapes in a 2D sketches. ontoCAD contains a pattern matching algorithm to find similar shapes that possibly represents a certain concept. In ESPRESSINDO, ontoCAD will be adapted and further developed for the data uplift into ontology.
2. **Knowledge manager** is a software that was initially developed in DAREED project. Knowledge manager is responsible to connect a high level data abstraction which is represented using ontologies to heterogeneous data sources. It allows the data-consuming applications to access data without knowing the location of the data sources. The knowledge manager provides API equipped with a user authentication system so that any authorized applications can access the managed data.

4.1.1.6 Previous projects and activities related to ESPRESSINDO

1. SWIMing (EU-H2020-CSA) as WP Leader

SWIMing has developed guidelines and best practices for generating open and accessible building data and publishing that data to the web. And to raise awareness of experts in academia and industry towards the

benefits of using open data standards and ontologies for building lifecycle energy management. The guidelines will help the construction of ESPRESSINDO knowledge graph.

2. DAREED (FP7-SMARTCITIES-2013) as Technical Coordinator and WP Leader

DAREED aims at delivering an IT service oriented platform to support decision-making and foster energy efficiency at district level. Project results will be validated via five pilots from three EU countries and, thus granting the possibility to generalize results and ensuring sustainability throughout Europe. The project targets decision-makers and energy providers at local level and is seeking to support them to overcome technological, financial and knowledge barriers and adopt new strategies for improving the energy performance. DAREED developed methods and tools for data integration using semantic web technologies and for ensuring the quality of integrated data in accordance with the data requirements.

3. KnoHolEM (FP7-2011-NMP-ENV-ENERGY-ICT-EeB) as Technical Coordinator and WP Leader

The KnoHolEM main objective is to improve energy efficiency in public buildings through progressive and intelligent knowledge modeling approach able to respond to changes in building configuration and use. The main project innovations are as follow:

- Alignment of the information model with standards (IFC-OWL mapping, CAD/IFC to OWL),
- Development of an expressive ontology knowledge base as the integration point in the system architecture and allowing reasoning
- 3D visualization of the building environment for the final user
- Data mining for extracting the energy consumption pattern in order to detect energy inconsistent performance and to generate energy consumption predictions
- Automated ontology population concept and tool (ontoCAD) that go beyond the state of the art technologies of similar EU projects.

Some of the KnoHolEM results will be exploited and adapted for the ESPRESSINDO projects:

- a. ontology development for the development of semantic middleware,
- b. data mining for the insight generator,
- c. ontoCAD for the data uplifting into ontology.

4. KlimaRA (industrially funded project)

As coordinator of this project KIT has been assigned to develop a knowledge based energy efficiency management and optimization for historical city hall in the state Baden-Württemberg by employing a building management system that gathers the energy, environment and occupancy data. The project utilizes ontology as representation of the knowledge base and data mining to extract the usage pattern from sensor data.

Conclusions

- Open innovation can shorten innovation funnel
- Open innovation requires ecosystems: triple helix model 3
- Triple Helix Model 3 requires transformation of all parties
- Collaborative open innovation projects require clear governance structure and communication flow
- Collaborative open innovation projects require data and intellectual property right management

Thank You

LinkedIn

<https://www.linkedin.com/in/hendrowicaksono/>

Facebook

<https://www.facebook.com/hendrowicaksono.9>

Email

h.wicaksono@jacobs-university.de
hendrowicaksono@green-indonesia.com

Homepage

<http://indeed.user.jacobs-university.de/>