Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Competences for the in-house development of digital innovations in German mechanical engineering companies

Steffen Kinkel
ILIN Institute for Learning and Innovation in Networks
Karlsruhe University of Applied Sciences

CONCORDi 2019, Seville, September 26th 2019

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Content

- **Background and Research Questions**
- **Methodology / approach**
- **Digitized products and services - develop in-house vs. buy**
- **Key competences for the digital transformation**
- **Measures to build up digitization competences**
- **Success factors for the digital transformation**

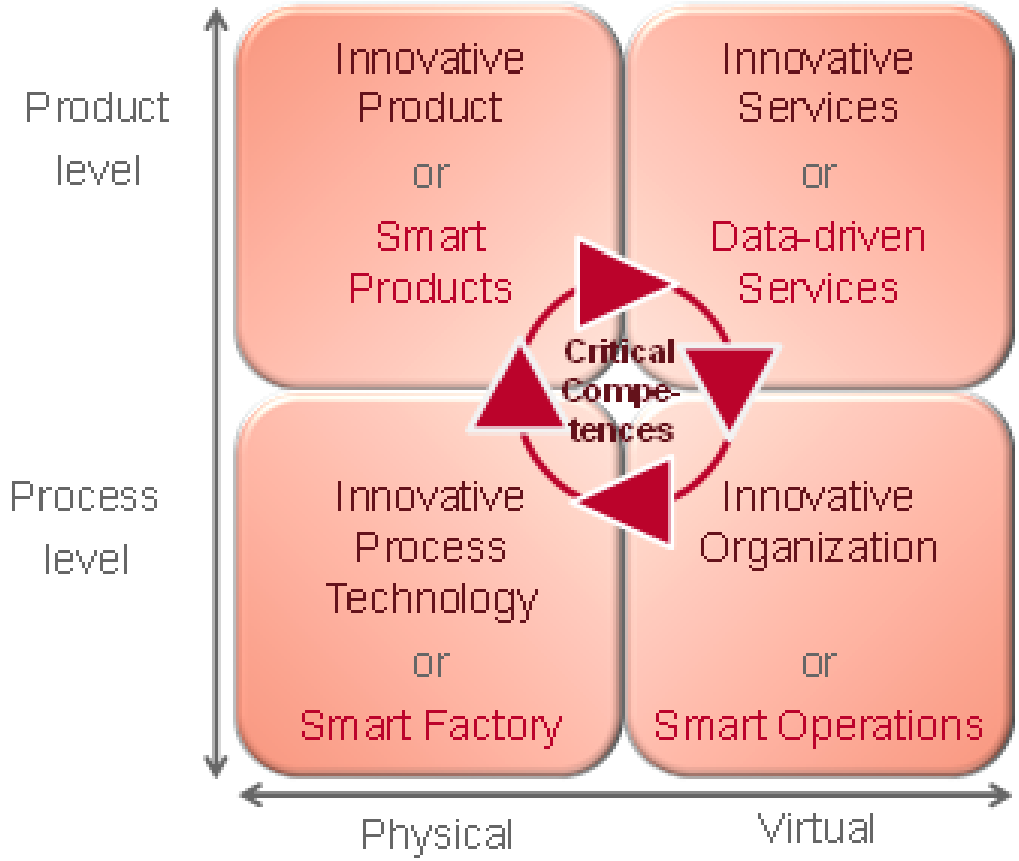
Background

- **Digital transformation** affects and connects more and more industrial areas and business processes (Dworschak and Zaiser, 2014; Kinkel et al., 2016), which is often referred to as a fourth industrial revolution or "Industry 4.0" / I4.0 (Bauerhansl, 2014; Lichtblau et al., 2015).
- **I4.0 will influence the way we will work in all its dimensions** (BAS, 2015). Disruptive technologies and structures for communication and collaboration will make work far more interconnected, interdisciplinary and complex (Zinn, 2015).
- The German **mechanical engineering** sector plays a key role as **provider and user** of digitally integrated products, processes and business models.
- However, it has **not yet been empirically investigated** to what extent mechanical engineering companies are able to independently develop digital products and services and what kind of competences they need to be able to do this successfully.

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Holistic understanding of industry 4.0 innovations

- Digital innovations need to be understood and designed as socio-technical systems
- Use 4-field-framework according to Kinkel et al., 2005, Lichtblau et al., 2015



Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Research questions

- **Which digitized products and services** do the companies of the German mechanical engineering sector **develop themselves** and consider them as core competences?

- Which are the **key competences and success factors** in order to ensure the **in-house development** and innovation capabilities for these digitally integrated offers?

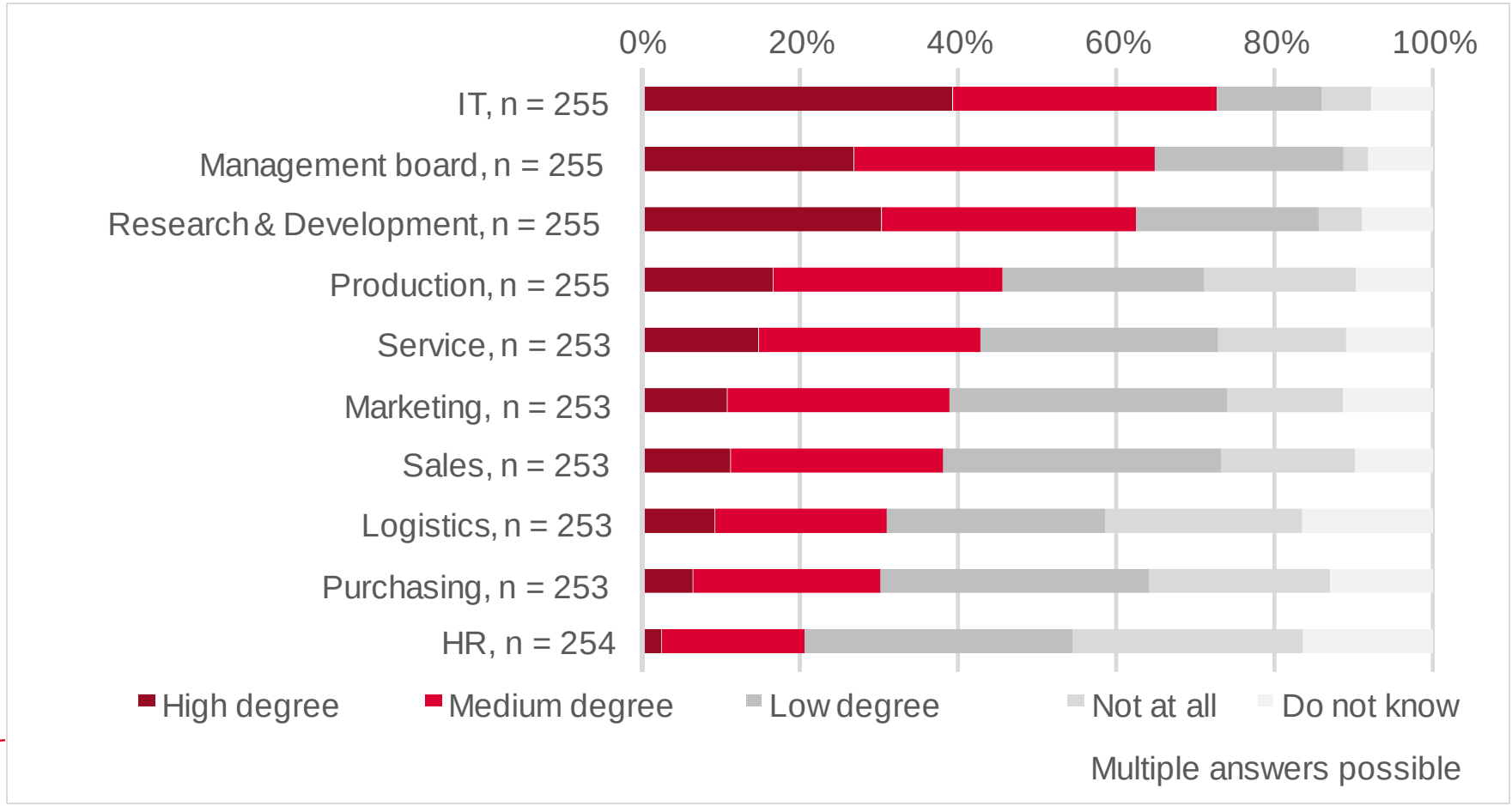
Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Methodology / approach

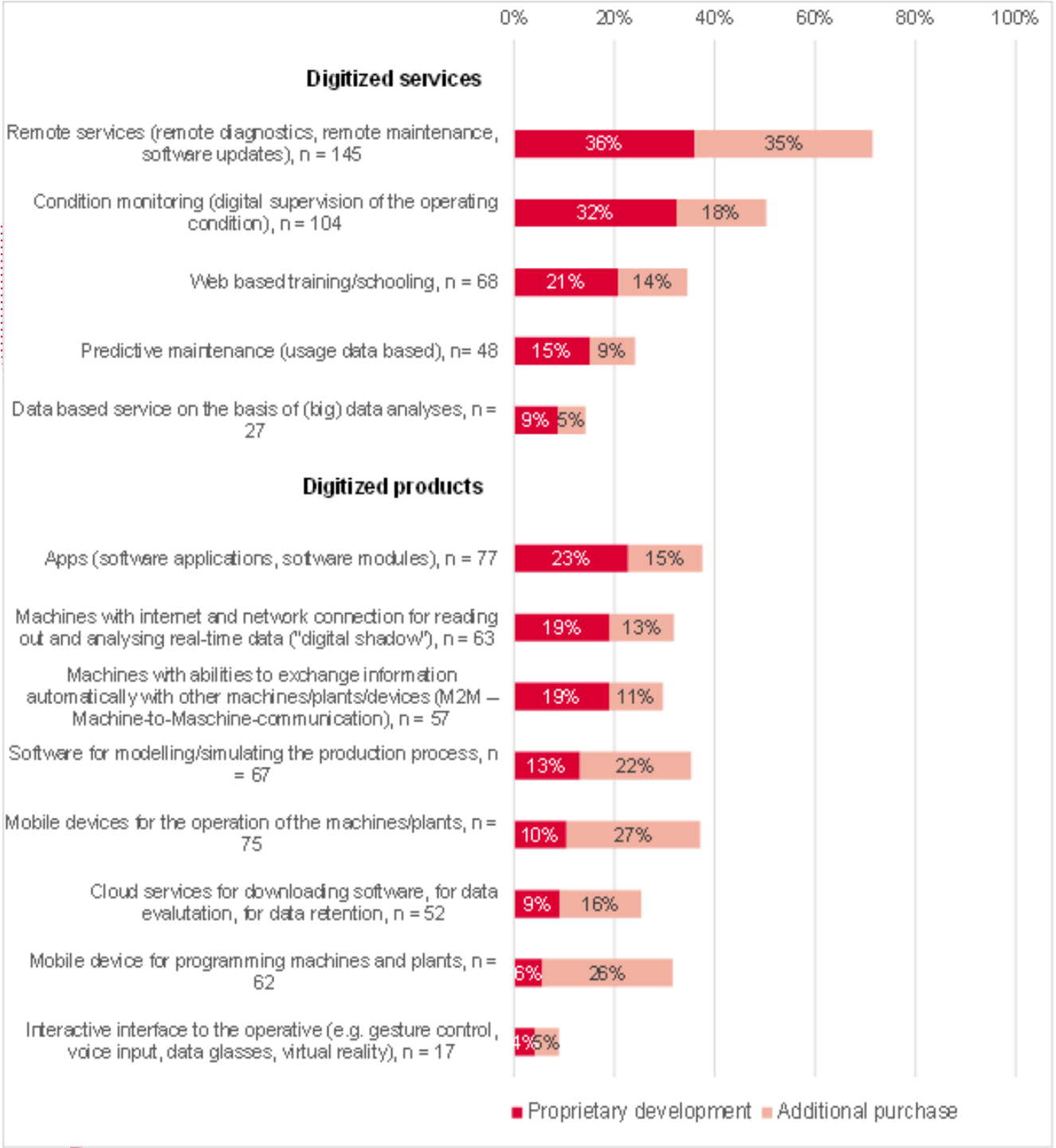
- **Online survey of 335 German mechanical engineering companies**, focusing on member companies of the German Mechanical Engineering Industry Association (VDMA)
  - 23% from small companies (<100 employees)
  - 41% from small to medium (100 - 499 employees)
  - 20% from medium to large (500 - 1999 employees)
  - 17% from large companies (≥ 2000 employees)
- **15 expert interviews** with representatives of companies, of which eight can be characterized as "pioneers" and seven as "beginners" in digitizing their products and services
  - Interviews were transcribed and analysed by two coders using MAXQDA

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Which business units are involved in digitization strategy development and execution?



- IT, Management Board and R&D are deeply involved in digitization strategy development and execution
- But HR is only involved in every 5th company!

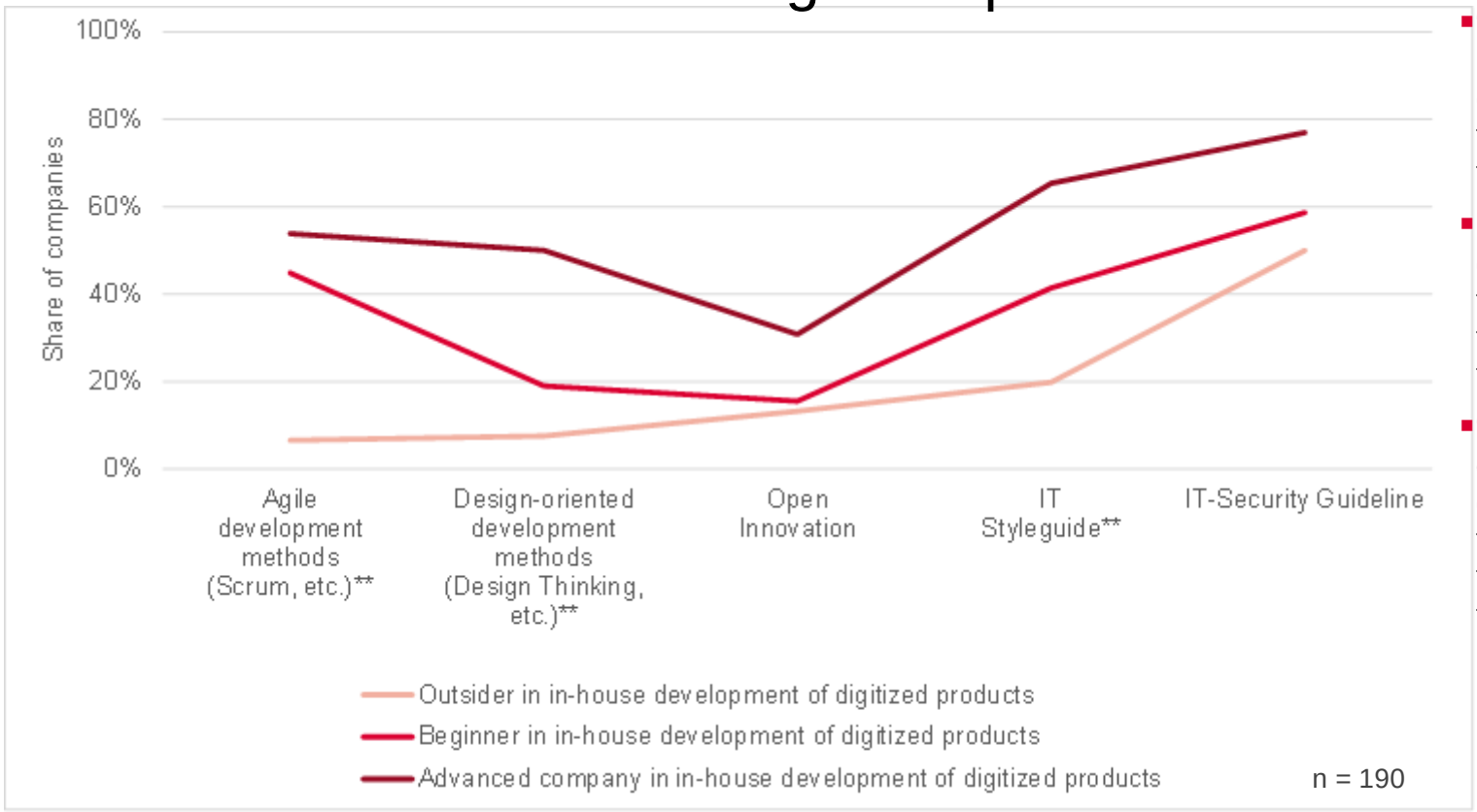


"Make or buy" of digital technologies for product and service offers

- Digitized service offerings such as predictive maintenance, condition monitoring, or modular apps are mainly developed in-house
- Here, the companies seem to see (future) core competences with potential benefits for their customers
- Mobile devices, cloud services, and simulation software are rather "bought off the rack"

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Use of development methods and in-house development of digitized products



- "Outsiders" have not developed any of the digital technologies themselves
- "Beginners" have developed one or two digitized technologies themselves
- "Advanced companies" have developed at least three digitized technologies themselves

- Companies that are "advanced" in in-house development of digitized products, use about eight times more frequently **agile development methods** than "outsider" companies
- **Design-oriented development** methods are applied six to seven times more frequently

⇒ But only every fourth to sixth company uses agile or design-oriented development methods

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Technical key competences for the digital integration of mechanical engineering companies

- Software development, especially for modular apps, interfaces, platforms
- Programming of machine and system controls
- IT security
- User-oriented IT design
- Data science

Integration of processes and different domains becomes vital (Schlund et al., 2017):

- Technical expertise in the fields of mechanics, electrical engineering, IT **and their integration**

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Non-technical key competences for the digital integration of mechanical engineering companies

Non-technical skills	Today	In 3 years
Ability to quickly capture and understand customer business models / customer problems	**3.41**	**3.56**
Ability for holistic, systemic thinking	3.27	**3.48**
Ability to analyse complex data and generate extra value for customers for the own business ("making sense of it")	3.13	**3.46**
Ability for interdisciplinary communication and cooperation	3.20	**3.42**
Ability for self-organization and independent planning	3.31	3.39
Ability to solve problems creatively	**3.56**	3.39
Ability to integrate different (technical) disciplines and competencies into a working solution	3.12	3.38
Ability to think in scenarios	2.97	3.18
Ability for intercultural communication and cooperation	2.82	3.08
1 = less important to 4 = very important, n = 147		

"*Engineers and computer scientists should work together in concrete projects in order to learn to understand the "different worlds"".*

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Measures and activities to build up digitization competences

- Measures to build up digitization competences include the classical canon of
  - internal knowledge management (83% of companies)
  - outsourcing software development to external service providers (82%)
  - professional training (77%)
  - cooperation with IT companies (74%)
  - recruitment (71%)
- Small businesses use recruitment less frequent (44%)

  → difficulties in attracting talents

Measures and activities to build up digitization competences (ff)

- A surprisingly high number (20%) of the surveyed companies do **spin-off own IT and software companies** – even small companies!
- The main reasons are
  - organizational separation to support the "two development speeds" of traditional mechanical engineering and agile software development,
  - overcome lock-in, better access to new industries and business models,
  - increased attractiveness of an independent, small software company for the recruitment of qualified IT staff.

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Managerial implications: Success factors for the digital transformation

1. **Cross-sectoral approach:** Broadly embed digitization strategy, strategically involve HR development
2. **Management of transformative change:** Create positive error culture and "courage for rapid failure"; “be brave and fail (and learn) fast"
3. **Testing and learning:** Agile approach - early experimentation and testing - is the key to the successful development of digital products and services
4. **Focus on service-based business models:** Create customer value along the product lifecycle
5. **Promote technical and non-technical skills:** E.g. facilitate cooperation of engineers and computer scientists in concrete projects in order to understand the "different worlds"
6. **Check all options for competence development:** Recruitment, training, cooperation – also spin-off of own IT companies

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Questions?

Prof. Dr. Steffen Kinkel

ILIN Institute for Learning and Innovation in Networks (www.ilin.eu)

Karlsruhe University of Applied Sciences

Moltkestr. 30, 76133 Karlsruhe

Tel.: +49 721 925-2915, Fax: -2965

steffen.kinkel@hs-karlsruhe.de