The Use of Digital Resources by the Aging Generation

Prof. Dr. Heiko Gewald

Center for Research on Service Sciences (CROSS)
Neu-Ulm University of Applied Sciences, Germany
About the author (and his home institution)…
Neu-Ulm – the young Bavarian city on the Danube

- **Location**: South Germany
- **Federal state**: Bavaria
- **Population**: ~60,000
- **Population of Ulm metro area**: ~200,000

- Twin-City with Ulm (federal state Baden-Wurttemberg)
- Ulm and Neu-Ulm are divided by the river Danube
- Neu-Ulm is conveniently located between Stuttgart and Munich
Ulm and Neu-Ulm – two cities, one metro region

Three Universities
- University of Ulm
- University of Applied Science Ulm
- University of Applied Science Neu-Ulm

Strong Economic Area
- Daimler TSS, Ratiopharm (TEVA), Beurer, Hartmann, Braun,…

Famous Sons of the City
- Albert Einstein
- Uli Höneß

…and the world’s
- highest church steeple
- most crooked hotel
Neu-Ulm University of Applied Sciences (HNU)

- One of the youngest universities in Germany (just turned 20…)
- About 4,000 students in three faculties
  - Business & Economics
  - Information Management
  - Health Management
- Around 90 full professors
- Languages of instruction:
  - German and English
- Eight bachelor study courses, two master courses (MSc) and several MBA programs
Center for Research on Service Science (CROSS)

What are we doing?

We conduct high-class research and teaching, and transfer our knowledge into practice.

The Center for Research on Service Sciences (CROSS) is focused on research on the production and management of services within and between companies.

Interdisciplinary  
Rigor and Relevance  
International
We deal with complex highly interactive matters
We target specific research areas

- Adoption, Resistance, Continuous Use
- Business-/ IT-Alignment
- Intra- and Interorganisational Collaboration
- Healthcare
- The Elderly
- IT Management
Some research on old people…
Mature Adults’ Use of Digital Health Services: 
The Role of Prior Computer Experience on eHealth Adoption

Heiko Gewald and Robert Rockmann

Neu-Ulm University of Applied Sciences
Center for Research on Service Sciences (CROSS)
Germany
Introduction

**eHealth – Active Control of Health and Well-being**

Electronic Health (eHealth) refers to “health services and information delivered or enhanced through the Internet or related technologies” (Eysenbach 2001, p. 1)

eHealth aims to enable consumers to take **active control of their health and well-being** by making health resources available to a broad audience via the Internet (Rozenkranz et al. 2013)

The Internet has become a major source for health information and decision support: **61% of all adults in the US** access information about their **illnesses and treatment options** (Fox and Jones 2009; Kummervold et al. 2008)
Developed economies face a significant shift in their age structure through steady increase of elderly people* (OECD 2013)

The demographic change asserts high pressure on healthcare systems, as diseases increase with age (Robert-Koch-Institut 2006)

eHealth is regarded as a prime measure for improving seniors’ well-being while saving resources in healthcare systems (Eysenbach 2001)

However, unfolding these potentials is contingent upon the extent to which such eHealth offerings are used by the elderly

* For the purpose of this study being defined as 65+ years of age and retired.
The integration of elderly people in our modern societies depends increasingly on their ability to master new technologies, especially computer technologies (Marquié et al. 2002, p. 273).

The focus of the digital divide shifted from an ‘access divide’ to a ‘skill divide’ (Dewan and Riggins 2005).

Thus, an important question is: how and where seniors gained their abilities to use computer technologies.

Given that many working places increasingly relied on computers, older adults might have gained abilities during their worktime.

What is the relationship between previous computer experience at work and eHealth adoption by older adults?
As recently empirically proven: **mature adults are not a homogenous group** in their technology use behavior (e.g. Niehaves and Plattfaut 2014)

**Individual differences in technology use** have become an important avenue for research (Agarwal and Prasad, 1999).

Despite basic demographic factors, research highlights **IT-related traits as important differentiators** of technology use behavior: Computer Self-Efficacy, Computer Anxiety, Personal Innovativeness in IT, Computer Playfulness (Maier, 2012; Thatcher and Perrewe, 2002).

Seniors’ abilities to use computers (i.e. **computer self-efficacy**) and **anxieties** of computers have been found to be **key predictors** of their Internet use (Niehaves and Plattfaut 2014)
Grounded in Social Cognitive Theory, **Self-Efficacy** is the “belief in one’s capability to organize and execute the courses of action required to manage prospective situations” (Bandura 1997, p. 2)

**Computer Self-Efficacy** is defined as the “judgment of one’s capability to use a computer” (Compeau and Higgins 1995, p. 192)

**CSE is a key predictor** of older adults’ Internet Use (Lam and Lee 2006; Niehaves and Plattfaut 2014)

CSE is mainly determined by **training and experiences** and influences IT behavior both directly and indirectly (Agarwal et al. 2000; Venkatesh 2000; Compeau et al. 1999; Marakas et al. 1998)

Despite training, little is known about **the specific determinants of mature adults’ CSE** (Tams et al. 2014)
Background

Computer Anxiety (CA)

CA describes the tendency of individuals to be _uneasy, apprehensive or fearful_ when using computers, such as data loss or other (irreversible?) mistakes by the user. (Heinssen et al. 1987; Parasuraman and Igbaria 1990)

Individuals with higher computer anxiety pose _higher negative attitudes_ towards computers, perceive computers as _difficult to use_ and as _less useful_ (Powell 2013)

Older individuals often possess higher computer anxieties than younger people (Powell 2013)

Training, experience, and computer use have been found to _significantly decrease_ individual’s computer anxieties (Powell 2013)
**Research Model**

**eHealth Use**: use of computer technologies to support one’s health

A multifaceted variable that depicts using computer technologies to:

- look up general health information
- research healthcare providers to seek medical care
- manage one’s health regimen online
**Outcome Expectations:** perceived likely consequences of how using eHealth will positively impact one’s health status and well-being.

Older adults often consider novel technologies as irrelevant for their daily life leading them to reject technologies (Chen and Chan 2011)

**H1:** Outcome Expectations positively affect seniors’ eHealth Use
**Research Model**

**Computer Self-Efficacy:** judgments of one’s capabilities to use computers

**Social Cognitive Theory:** (Bandura 1982, 1997)

- **H2:** Belief in one’s abilities determines actual behavior; seniors who feel able to use computers are likely to make use of eHealth.

- **H3:** Self-efficacy beliefs determine one’s expectations about the outcome; seniors who feel able to use computers likely form positive perceptions about the usefulness of eHealth for their health and well-being.
**Research Model**

**Computer Anxiety:** Tendency to be uneasy, apprehensive or fearful when confronted with using computers

**Social Cognitive Theory:** (Bandura 1982, 1997)

- **H4:** One’s emotional arousal interacts with one’s self-efficacy beliefs; seniors who posses anxieties towards computers will tend to demonstrate lowered self-efficacy judgements

---

Prof. Dr. Heiko Gewald | Neu-Ulm University | Center for Research on Service Sciences (CROSS)
Past Work IT Intensity: One’s previous exposure to computer technologies at the workplace before retirement.

Computer self-efficacy and anxieties can be altered through training and direct computer experiences (Marakas et al. 1998)

- **H5 & H6:** Higher IT exposure at the workplace increases one’s computer self-efficacy and decreases one’s anxieties towards computers.
- **H7 & H8:** These relationships decrease the longer a senior is retired.
Research Method – Quantitative Study (PLS)

Measurement Instrument (Questionnaire)
- Derived and adapted from established literature
- Discussed and validated with academics and the target group.
- **Paper-based questionnaire** (to avoid technology-savvy bias)

Data collection (October / November 2015)
- Public places: Senior citizen centers, adult education centers, shopping malls, pedestrian zones, etc. in the US
- Randomly asked people (who appeared to be 50+)
- Assurance of anonymity and that no ‘wrong/right’ answers exist.
- 234 survey collected, 69 respondents were younger than 55 and/or not retired, 33 questionnaires were incomplete. **132 questionnaires** constitute the basis for data analysis.
Our model explains **42.7% of mature adults’ eHealth Use**.

The magnitude of the significant paths (.206 to .564) indicates **strong relationships** between the proposed factors.

Formal mediation analysis: relationship between Computer Self-efficacy and eHealth Use is **entirely mediated by Outcome Expectations**.

Retirement does not have a moderating effects.
Discussion

Key Findings

- **Outcome Expectations** is the most important determinant in explaining mature adults’ use of eHealth.

- **Outcome Expectations** are highly determined by **Computer Self-Efficacy**, which is, in turn, largely determined by emotional states (**Computer Anxiety**) and prior exposure to computer technologies at the work place (**Past Work IT Intensity**).

- The relationship between Past Work IT Intensity and Computer Self-efficacy / Computer Anxiety is —surprisingly— not determined by the duration of being retired.
We proposed and empirically validated theory-guided causal mechanisms how mature adults’ eHealth Use behavior is influenced by their prior exposure to Information Technologies at the workplace.

We developed ‘Past Work IT Intensity’ as a novel and distinct determinant of mature adults’ Computer Self-efficacy and further provide evidence for its long-lasting effect (i.e., absence of retirement moderation).

Thereby, we contribute to research on eHealth and research on the causes of digital divide among senior citizens.
Seniors with previous occupational IT exposure are much more likely to use digital health services, than those with no occupational IT exposure.

Although seniors with previous IT experience feel confident using unknown technologies, they will use eHealth only when they see a strong personal benefit in eHealth services.

Strong support for new digital divide: Not infrastructure, but capabilities are asked for.
Recent CROSS publications on the same issue

Some current research projects…
Managed Innovation Cycle

Development of Subject Pool

Preliminary Talks

Design Challenge Definition

Final Presentation & Lessons Learned

Open Forum

Kick-Off

Creative Workshop

Creative Workshop

Creative Workshop

Two day workshops (Design Thinking)

Cooperation Agreements / Non-Disclosure Agreements
A Collaborative Innovation Programme

Collaborative Product Development involving:

- Users
- Companies
- NGOs
- Academics
Development Paradigms

User-Centric Design process – participation of senior citizens

Development of age appropriate solutions to support senior citizens
MELLI – Mein Leben und Ich

• Development of an App that is being used by seniors – frequently

• Move from traditional interaction to voice interaction

• Analysis of voice (modulation, not context)

• Calculation of a “cognitive baseline”

• Continuous analyses of voice modulation / comparison against baseline

• Analysis of deviation from baseline

• Hypothesis: Alzheimer/Dementia can be earlier detected by computerized analysis of voice than by family/caretakers
MELLI – Mein Leben und Ich
Some research projects to be started soon…
Projects in their starting phase

- **Cognitive Age vs. Physical Age**
  Do we measure what we want to measure?

- **Authentication Mechanisms for the Ageing Generation**
  Password, Knowledge, Biometrical or something completely different?

- **IT Security or the Ageing Generation (ITSAG)**
  Are seniors more prone to digital fraud and what can be done to prevent this?

- **Applying Activity Theory to Explain limited success of IT-Implementations in Hospitals**
  Identifying barriers to successful use of IT in the specific context of hospitals.
Areas for collaboration

- Health Informatics vs. Information Systems (better together)
- X-Country studies
- Exchange of researchers

I will be at the AIHI until April 12th in room 620
Just drop by 😊
Seniors' Use of Digital Resources

Submit your Research to

ICTH 2019
The 9th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare (ICTH 2019)
November 4-7, 2019, Coimbra, Portugal

Prof. Dr. Heiko Gewald | Neu-Ulm University | Center for Research on Service Sciences (CROSS)
Details of the empirical study…
## Research Method – Quantitative Study

### Sample Demographics (n=132)

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Marital status</th>
<th>Annual household income</th>
</tr>
</thead>
<tbody>
<tr>
<td>55-59</td>
<td>2%</td>
<td>Male</td>
<td>38% Single</td>
</tr>
<tr>
<td>60-64</td>
<td>7%</td>
<td>Female</td>
<td>62% Married</td>
</tr>
<tr>
<td>65-70</td>
<td>27%</td>
<td>Divorced</td>
<td>12%</td>
</tr>
<tr>
<td>70-74</td>
<td>26%</td>
<td>Retired</td>
<td>Widowed</td>
</tr>
<tr>
<td>75-79</td>
<td>20%</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>80-84</td>
<td>14%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85-89</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 90</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Measurement – Instrument

## eHealth Use (own construct)

<table>
<thead>
<tr>
<th>Items</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>I personally use the Internet to look up information about health related topics.</td>
<td>7-point 'not at all' to 'very often'</td>
</tr>
<tr>
<td>I use computer-technology to research healthcare providers before making a decision to seek medical care.</td>
<td></td>
</tr>
<tr>
<td>I personally use a computer-technology application to manage my healthcare regimen.</td>
<td></td>
</tr>
<tr>
<td>I currently use computer-technology that automatically collects health data about myself.</td>
<td></td>
</tr>
</tbody>
</table>

## Outcome Expectations (adapted from Compeau and Higgins 1995)

<table>
<thead>
<tr>
<th>Items</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>I believe using computer-technologies by my own will support critical aspects of my own healthcare.</td>
<td>7-point 'strongly disagree' to 'strongly agree'</td>
</tr>
<tr>
<td>I find using computer-technologies by my own useful for my own healthcare.</td>
<td></td>
</tr>
<tr>
<td>I believe using computer-technology by my own will improve the quality of my own healthcare.</td>
<td></td>
</tr>
</tbody>
</table>
Measurement – Instrument

Computer Self-Efficacy (Compeau and Higgins 1995)

Often we are told about new computer-technologies (e.g. computers, smartphones, tablets, or applications) that are available to make our lives easier. For the following questions, imagine that you were given a new computer-technology for some aspect of your daily life. It doesn’t matter specifically what this technology does, only that it is intended to make your life easier and that you have never used it before. The following questions ask you whether you could use this unfamiliar computer-technology under varying conditions. For each of the conditions, please indicate how confident you are to use this computer-technology.

<table>
<thead>
<tr>
<th>Items</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>I could use an unfamiliar computer-technology...</td>
<td>10-point 'not at all confident’ to ‘totally confident’</td>
</tr>
<tr>
<td>if there was no one around to tell me what to do as I go.</td>
<td></td>
</tr>
<tr>
<td>if I had never used a computer-technology like it before.</td>
<td></td>
</tr>
<tr>
<td>if I had only the manuals for reference.</td>
<td></td>
</tr>
<tr>
<td>if I had seen someone else using it before trying it myself.</td>
<td></td>
</tr>
<tr>
<td>if I could call someone for help if I got stuck.</td>
<td></td>
</tr>
<tr>
<td>if someone else had helped me get started.</td>
<td></td>
</tr>
<tr>
<td>if I had a lot of time to complete the task for which the computer-technology was provided.</td>
<td></td>
</tr>
<tr>
<td>if I had just the built-in help facility for assistance.</td>
<td></td>
</tr>
<tr>
<td>if someone showed me how to do it first.</td>
<td></td>
</tr>
<tr>
<td>if I had used similar computer-technologies before this one to do the same task.</td>
<td></td>
</tr>
</tbody>
</table>
## Measurement – Instrument

### Computer Anxiety (Venkatesh et al. 2003)

<table>
<thead>
<tr>
<th>Items</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel apprehensive about using computer-technologies.</td>
<td>7-point ‘strongly disagree’ to ‘strongly agree’</td>
</tr>
<tr>
<td>It scares me to think that I could lose a lot of information using a computer-technology by hitting the wrong key or button.</td>
<td></td>
</tr>
<tr>
<td>I hesitate to use computer-technologies for fear of making mistakes I cannot correct.</td>
<td></td>
</tr>
<tr>
<td>Computer-technologies are somewhat intimidating to me.</td>
<td></td>
</tr>
</tbody>
</table>

### Past Work IT Intensity (own construct)

<table>
<thead>
<tr>
<th>Items</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using computer-technologies is/was part of my daily job routine(s).</td>
<td>7-point ‘strongly disagree’ to ‘strongly agree’</td>
</tr>
<tr>
<td>Most of my work is or was done with computer-technology.</td>
<td></td>
</tr>
<tr>
<td>Computer-technology use is or was important in my job(s).</td>
<td></td>
</tr>
</tbody>
</table>

### Retirement

I have been retired for _______ years
# Measurement Model – Validity and Reliability

## Discriminant Validity

<table>
<thead>
<tr>
<th>#</th>
<th>Construct</th>
<th>Loadings</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Past Work IT Intensity</td>
<td>0.951 - 0.969 ***</td>
<td>0.961</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Computer Self-Efficacy</td>
<td>0.832 - 0.921 ***</td>
<td>0.490</td>
<td>0.875</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Computer Anxiety</td>
<td>0.803 - 0.940 ***</td>
<td>-0.246</td>
<td>-0.557</td>
<td>0.903</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Outcome Expectations</td>
<td>0.952 - 0.966 ***</td>
<td>0.314</td>
<td>0.534</td>
<td>-0.225</td>
<td>0.962</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>eHealth Use</td>
<td>0.654 - 0.837 ***</td>
<td>0.203</td>
<td>0.447</td>
<td>-0.223</td>
<td>0.642</td>
<td>0.774</td>
</tr>
</tbody>
</table>

### Average Variance Extracted (AVE)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVE</td>
<td>0.923</td>
<td>0.765</td>
<td>0.815</td>
<td>0.925</td>
<td>0.599</td>
<td></td>
</tr>
</tbody>
</table>

### Composite Reliability (CR)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>0.973</td>
<td>0.970</td>
<td>0.946</td>
<td>0.974</td>
<td>0.855</td>
<td></td>
</tr>
</tbody>
</table>

### Cronbach's Alpha (CA)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>0.959</td>
<td>0.966</td>
<td>0.924</td>
<td>0.960</td>
<td>0.775</td>
<td></td>
</tr>
</tbody>
</table>

### Mean

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.21</td>
<td>5.34</td>
<td>3.23</td>
<td>4.24</td>
<td>2.76</td>
<td></td>
</tr>
</tbody>
</table>

### Standard Deviation (SD)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>2.26</td>
<td>2.45</td>
<td>1.86</td>
<td>1.71</td>
<td>1.67</td>
<td></td>
</tr>
</tbody>
</table>

**Measurement Model Validation Guidelines** (Chin 1998)

- Item Loadings should be at least .70 and significant. In cases of exploratory research and/or new constructs, item loadings of .50 or 0.60 are still acceptable.
- Reliability: Composite Reliability and Cronbach’s Alpha should exceed 0.70.
- Values for average variance extracted (AVE) should be at least .50 (Fornell & Larcker 1981).
- Discriminant validity is given when construct correlations are smaller than the square root of AVE (Fornell & Larcker 1981; Hulland 1999).
Mediation Analysis

Mediation Analysis as per Hair et al. (2013)

- Step 1: Direct, significant effect of Computer Self-efficacy (CSE) on eHealth Use (USE) without the mediating variable Outcome Expectations (OE).
- Step 2: Indirect, significant effects of CSE on OE and OE on USE without the direct effect of CSE on USE.
- Step 3: Mediator model in which the former direct effect of CSE on USE strongly decreases due to the presence of the mediator variable OE.
- Step 4: In order to determine the size of the mediating effect, Variance-Accounted-For (VAF) was calculated. The resulting VAF score of 0.677 and the insignificant direct effect of CSE on USE indicates a mediating effect.

Significance levels: *** p < 0.001, ** p < 0.01, * p < 0.05, ns = not significant