University of Cologne

Faculty of Management, Economics and Social Sciences

Cologne Institute for Information Systems (CIIS)

Professorship for Information Systems

Sustainable Digital Innovation Lab

Course Instructors

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Registration and Contact

Due to limited course capacity available, please contact Christian Hovestadt (hovestadt@wiso.uni-koeln.de) in advance if you are interested in enrolling in the course.

Goals of the Module

Students …

… understand what digital innovation means and learn about important related concepts.

… learn about potentials of emergent digital technologies.

… understand challenges related to designing information systems for digital innovations.

… develop an idea for a digital innovation by incorporating latest digital technologies.

… develop a socio-technical artifact based on their idea.

… organize themselves and work in independent teams.

… manage time, team, and project conflicts independently.

… communicate processes and outcomes to relevant stakeholder groups.

Content

In this unit, we simulate a project-based digital innovation lab. The objective is to develop a novel digital solution to a chosen sustainability innovation challenge. With this objective, we have two specific foci.

1. Address a Sustainability Innovation Challenge

We define a sustainability innovation challenge as a problem of either environmental or social but not primarily commercial value (George et al. 2020; Qureshi et al. 2021). For inspiration, we consider the *Sustainable Development Goals of the United Nations,* which provide a set of goals and an agenda for peace and prosperity. Another source of inspiration for environmental sustainability in innovation challenges is the *Fridays for Future* movement, which emerged from school strikes demanding action to prevent further global warming. As concrete project examples consider the *Fairphone* – a highly modular smartphone that accounts for conflict-free production resources, worker welfare and e-waste programs – or *Wakawaka* – a solar-powered lamp providing 16 hours of reading light on less than a day of sunlight. What we do not consider to be sustainability innovation are, for example, lean manufacturing approaches that are directed primarily to increase efficiency in production processes and which may only reduce waste as a side effect. Other negative examples are greenwashed products and practices that make unsubstantiated or even misleading claims about their environmental benefits (e.g., reducing the carbon footprint). Our goal is to help students understand grand sustainability challenges facing current and future generations. We seek to advance students' understanding of the solution potential of information systems to address these challenges.

2. Develop a Digital Artifact as a Solution to the Innovation Challenge

The digital solution must consist of both hardware and software components. For the hardware components, we will provide a selected hardware technology stack for students to work with. The students' task is then to develop a software solution for the hardware technology stack such that a digital innovation can be realized. For illustration, consider these examples:

- Vertical Hydroponic Farm Arduino Project (Langdon 2015)
- Self-powered water meter for direct feedback to safe water consumption (Tasic et al. 2012)
- Meter devices for smart and energy-efficient school buildings (Pocero et al. 2017)
- Open source low-cost power monitoring system (Oberloier and Pearce 2018)
- Wireless sensor network system for environmental monitoring applications (Ferdoush and Li 2014)
- A datalogger for irrigation water use monitoring to enable crop management (Spinelli and Gottesman 2019)

With these foci, the contents of the unit roughly unfold in the following way:

- Introduction to digital innovation
- Grand challenges and wicked problems of a sustainable society
- Selected emergent digital technology stacks
- Systems development practices suitable for complex contexts and requirements
- Project and team management
- Design and implementation of information systems
- Prototyping and Testing

Procedure

Students will form teams to complete this unit. In teams, they are free to choose the problem settings to be addressed within their digital innovation project. A selection of hardware technologies will be available at the beginning of the course to allow students to start experimenting immediately. Team formation is scheduled for the kick-off session. Prior to this, students are encouraged to familiarize themselves with some preparation material and to complete a brief survey that can be used for team formation. During the semester, students will be able to use a fixed budget to buy additional hardware components such as sensors, extensions, motors, tools, etc. for their projects on an as-needed basis. Orders have to be issued through the course instructors.

Over the course of the semester, student teams will continuously work on developing their digital innovation solution. The course will include a series of accompanying lectures, tutorials, and interactive workshops. For the workshops, students will be provided with resources and materials in advance to prepare for the workshop in a flipped-classroom style.

The final report and solution should be submitted using a free and open-source design solution that meets the requirements of a professional outlet such as *HardwareX* – an open-access journal established to promote the free and open-source design, construction and customization of scientific infrastructure (hardware). Therefore, reports must provide potential end-users with sufficient information to replicate and validate the advances presented. More information on documentation requirements and examples can be found on the journal's website. As a compatible open-source license model, we recommend the *General Public License (GNU).*

Technology Stack

We provide students with hardware technologies, which can be used to start experimentation and trial right from the start. The following list is intended as a guide for getting starting, rather than a comprehensive list of technologies that can be used.

- Arduino Hardware Platform – central part is an open-source microcontroller board, including integrated development environment
    - Official Site: https://www.arduino.cc/
    - Arduino Project Hub: https://create.arduino.cc/projecthub
- Circuit.io – prototyping tool for instant circuit schematics and code for electronic circuit
    - Official Website: https://www.circuito.io
    - Blog: https://www.circuito.io/blog
- GitHub – software platform for version control, collaboration, source code management; one of the largest hosts of public source code:
    - Official Website: https://github.com/
    - GitHub Guides: https://guides.github.com/

For further inspiration on technologies and tools to use, students should take a look at *Stackshare.io,* which provides lists of technology stacks and tools.

Time Slot and Room

For team and lab work, we have booked classrooms throughout the semester located in the Pohlighaus (https://www.is4.uni-koeln.de/de/contact/). For workshops and lectures, please refer to the schedule in KLIPS2 and ILIAS.

Examination

The portfolio examination comprises three assessments.

Overview of the Elements of the Portfolio

Assessment	Assessment Weighting	Type of Assessment	Deliverables
#1: Problem definition	10%	Group	Materials for presentation
#2: Solution concept and prototype	20%	Group	Materials for presentation
#3: Project report and working solution presentation	70%	Group	Written report, materials for presentation

Assessment 1: Problem definition

Students formulate their problem description including motivation and relevance. The problem definitions should already include the type of innovation and stakeholders, possibly the range of technologies involved. Students present their deliverable in an adequate format.

Assessment 2: Solution concept and prototype

Students formulate their solution concept. The reports address the planned digital technology solution to serve as a blueprint. An integral part is the description of the group's development method and project plan. Feasibility tests and prototypes, schematic diagrams, mock-ups, and other useful forms of early design should be included. Students present their deliverable in an adequate format.

Assessment 3: Project report and working solution presentation

Students formulate a detailed report of their project. The working solution is described and adequately presented. The assessment comprises two parts: (1) the project report and (2) the presentation of the working solution.

Introductory Reading Materials and Resources

Resources:

- Fairphone (website): https://www.fairphone.com/en/
- Fridays for Future (website): https://www.fridaysforfuture.org/
- General Public License (GNU) – free, copyleft license for software and other kinds of works: https://www.gnu.org/licenses/gpl-3.0.en.html
- HardwareX Journal (website): https://www.journals.elsevier.com/hardwarex
- Stackshare.io (website): https://stackshare.io/
- United Nations, Sustainable Development Goals Agenda (website): https://sustainabledevelopment.un.org/?menu=1300
- Wakawaka (website): https://waka-waka.com/en/

References:

Ferdoush, S., and Li, X. 2014. "Wireless sensor network system design using Raspberry Pi and Arduino for environmental monitoring applications," *Procedia Computer Science* (34), pp. 103-110.

George, G., Merrill, R. K., and Schillebeeckx, S. J. 2020. "Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development," *Entrepreneurship Theory and Practice* (45:5), pp. 999-1027.

Langdon, P. 2015. "Vertical Hydroponic Farm." from https://create.arduino.cc/projecthub/bltrobotics/vertical-hydroponic-farm-44fef9?ref=platform&ref_id=424_respected___&offset=2

Oberloier, S., and Pearce, J. M. 2018. "Open source low-cost power monitoring system," *HardwareX* (4).

Pocero, L., Amaxilatis, D., Mylonas, G., and Chatzigiannakis, I. 2017. "Open source IoT meter devices for smart and energy-efficient school buildings," *HardwareX* (1), pp. 54-67.

Qureshi, I., Pan, S. L., and Zheng, Y. 2021. "Digital social innovation: An overview and research framework," *Information Systems Journal* (31:5), pp. 647-671.

Spinelli, G. M., and Gottesman, Z. L. 2019. "A low-cost Arduino-based datalogger with cellular modem and FTP communication for irrigation water use monitoring to enable access to CropManage," *HardwareX* (0:0).

Tasic, V., Staake, T., Stiefmeier, T., Tiefenbeck, V., Fleisch, E., and Tröster, G. 2012. "Self-powered water meter for direct feedback," *2012 3rd IEEE International Conference on the Internet of Things*: IEEE, pp. 24-30.

Schedule

Week	Date	Time	Topic
1	Thu, 12.10.2023	10:00-13:30	*Kick-off Workshop* Lecture part: • Introduction to course topic • Organization & procedures • Resources Workshop part: • Team formation • Playful exploration of technologies Deliverable(s): • Team formation • Technology setup
1	Fri, 13.10.2023	10:00-15:30	*Initiation Workshop* Lecture parts: • Guest lectures for inspiration and problem scoping • Lecture with details about hardware technologies Workshop parts: • Problem scoping techniques • Wrap-up & learnings Deliverable(s): • Topic selection • Problem scoping
2	Mon, 16.10.2023	08:00-11:00	*Ideation Workshop* Lecture parts: • Introduction to digital innovation • Wicked grand challenges Workshop parts: • Systemic Ideation • Design thinking techniques Deliverable(s): • Problem formulation • Solution ideating

4	Thu, 02.11.2023	10:00-13:30	Presentation of Problem Definitions (Assessment 1)
5	Thu, 09.11.2023	10:00-13:30	Conducting User Research
6	Thu, 16.11.2023	10:00-13:30	Design Approaches for Digital Innovations
7	Thu, 23.11.2023	10:00-13:30	Presentation of Solution Concepts (Assessment 2)
12	Thu, 11.01.2024	10:00-13:30	Pitching your Solution
14	Thu, 25.01.2024	10:00-13:30	Final Presentations (Assessment 3)