Information and Market Engineering at KIT: Quo Vadis?

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Abstract Information systems (IS) are nowadays at the core of many personal and institutional activities and influence daily life more than ever before. To understand, evaluate and envision the forms of how we interact with IS, interdisciplinary and multifaceted research efforts are required. At the Information and Market Engineering chair at the Karlsruhe Institute of Technology, this task is taken head-on via research that stretches from user experiences to system design. In this review, the present research foci at the department are outlined, together with a brief description of its origins and the global developments that underly the necessity of conducting these particular IS studies.

1 Introduction

With the turn of the millennium, information technology (IT) had become an omnipresent phenomenon in people's lives and minds. The fearfully anticipated Y2K problem vividly demonstrated how widely IT-based systems had spread and how dependent many aspects of our lives had become on it. However, in the following years, instead of slowing down, the speed of IT-based system diffusion rapidly increased, weaving these systems into the fabric of our lives more than ever. A striking example of this development is the ranking of global companies' market capitalization. Whereas in the beginning of the 2000s, companies like Exxon, General Electric, Total and Citibank were in the top five of publicly traded companies, they have step by step been overtaken by companies like Apple, Alphabet,

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Microsoft, Amazon and Facebook by the end of 2015.[1] Similarly, firmly established business sectors have been uprooted by the emerging digital competition, as can be seen in the sharing economy where services like Uber and Airbnb have become major competitors to traditional mobility and lodging offerings. Nowadays, almost all economic decisions in business and everyday life are supported by IT-based systems. These systems increasingly "cast in code" institutions and processes and influence the interactions and behaviour of decision-makers. Most recently, the importance of acknowledging the impact that these digitization processes have is embodied in the public and scholastic recognition of how social media platforms influence individual, social and institutional functioning. The wilful capitalization on biological reward mechanisms to increase IT use and the staggering increase of psychological ailments such as addictive tendencies, anxiety, stress and loneliness driven by the ever-attention-demanding social media applications and platforms (Kloker et al. 2020) represent issues on the individual and social level. On the institutional level, tendencies of increased political radicalization and public opinion manipulation (e.g. in elections) represent problematic and fundamental challenges imposed by today's ubiquity of IT-based systems. At the same time, IT-based systems still offer unprecedented potential to improve societies and human lives through democratic empowerment (e.g. through digital participation in governmental decision-making), ecological sustainability (e.g. through information and market access related to the ongoing energy transition) or data-driven economic and technological innovation (e.g. through the identification of insights in big data).

In this dynamic world, the interplay between economic decision-making and system design has become a core of IS research in general and research at the Information and Market Engineering (IM) chair at the Karlsruhe Institute of Technology (KIT) in particular. Over the years, research at the IM chair has covered a variety of topics that tackle the aforementioned individual, social and institutional challenges of IT-based systems. This chapter focuses on the most recent developments and research directions at the IM chair. In particular, this chapter aims to present a focused view on the present work in the sectors of energy markets, data analytics, user behaviour, digital experience and digital participation. This represents the work of research departments that are formed within the IM chair today. To provide an introduction on how these departments emerged, the following section provides a brief overview of the research topic developments in the form of IM dissertation-based text analysis. Afterwards, in the third section, an overview of the current department's work is given, including pressing global IT-based system developments and derived fields of research.

[1] Visual Capitalist Report, https://www.visualcapitalist.com/chart-largest-companies-market-cap-15-years/. Last accessed 30.10.2020.

2 A Brief Overview of Past IM Research

To gain an impression of the evolution of the research at the IM chair, abstracts and introductions of the dissertations that were completed since 2006 were analysed. The data includes all dissertations in that period that were available at the digital library of the KIT—55 dissertations in total. While this does not include all dissertations handed in at the chair, it suffices to give an overview of the prevalent research topics over the years. Using these dissertations, a wordcloud was created for the periods from 2006 to 2012 (Fig. 1), 2013 to 2016 (Fig. 2) and 2017 to 2020 (Fig. 3). The identified trends are based on a simple descriptive and subjective approach. That being said, every reader is invited to develop their own story around these results.

In the first wordcloud of 2006 to 2012 (there are only three dissertations from 2006 to 2008 that were included, which is why this is the longest period) in Fig. 1, the traditional topics of the IM chair are central. Markets, systems and auctions are essential to the dissertations in this period. Other words such as service, economic, electronic, network, price or performance further show that electronic markets

Fig. 1 Wordcloud of 23 dissertations at the IM chair in the period from 2006 to 2012

Fig. 2 Wordcloud of 18 dissertations at the IM chair in the period from 2013 to 2016

Fig. 3 Wordcloud of 14 dissertations at the IM chair in the period from 2017 to 2020

represent the core and the legacy of the IM chair. Additionally, some topics that are central during this time and less relevant later are cloud and web-based services, retail markets or market liquidity.

Moving on to the period of 2013 to 2016 in Fig. 2, it can be seen that new domains are becoming important at the IM chair. While markets, auctions, systems and services are still central to research, healthcare, energy, grid, economics and regulation show that new directions are taken such as research on energy or telecommunication markets. Competition becomes a more important topic, but more user-centric research can also be observed in the emergence of terms like social, human, cognitive or arousal. This already announces the increasingly important experimental focus at the IM chair.

This trend continues in the period from 2017 to 2020 in Fig. 3. While markets and systems remain the centrepieces of research activities, other topics are less pronounced. Auctions, for example, are being replaced by mechanisms. Behaviour takes a more central role, and services are becoming less important. It can be seen that the user takes a central position shown by the words behaviour, users and decision. The energy domain retains its central role, while telecommunication and healthcare have disappeared. Data is more strongly pronounced, which might be driven by the stronger experimental focus and the evolution of data analytics as a research domain. The words welfare and acceptance imply a more economical approach to certain topics.

Building on this previous work, today, the scholastic work at the IM chair is carried forward in four research groups named (1) Smart Grids and Energy Markets, (2) Business Data Analytics, (3) Electronic Markets and User Behaviour and (4) Digital Experience and Participation. The work in these groups carries on the established focus of creating knowledge and value from analysing and developing information systems and markets. With an emphasis on beneficial behaviours and systems, research in these groups today tackles emerging challenges of the new decade that are detailed in the following section.

3 Present and Future of IM Research

3.1 Smart Grids and Energy Markets

One of the most important issues of our time is the reduction of greenhouse gas emissions to limit climate change. The electricity sector is one of the most carbon-intensive energy sectors, but it is also the easiest to decarbonize. Wind and solar energy can replace fossil-fuelled conventional generation. Furthermore, electricity can substitute fossil fuel in the transportation and heating sector (Golla et al. 2019). Therefore, decarbonizing the electricity sector is the most straightforward path to achieve global emission objectives. The European Union and its member states are committed to reducing carbon emissions, and Fridays for Future and affiliated organizations are gaining momentum worldwide. The research group Smart Grids and Energy Markets (SGEM) is committed to contributing to the decarbonization of all energy sectors through market mechanisms and information system solutions. The objective of the research group is stated as follows:

> We develop and evaluate economic mechanisms to coordinate supply and demand in digitalized energy systems. The overall objective is the development and the support of a sustainable energy system considering individual preferences and developments in our society.

The evolution of the SGEM group is described in a different chapter of this book. The group has accompanied the major evolution of energy markets in Europe and beyond. This includes research on market liberalization (van Dinther et al. 2006), market power (Veit et al. 2009), demand-side flexibility (Gärttner et al. 2018), electric vehicles (Schuller et al. 2015) and most recently decentralized electricity markets and market regionalization (Staudt et al. 2017). However, with the current trends of decarbonization, market engineering approaches are only gaining momentum in energy market research. Two major research directions are highlighted here that focus on energy consumer/user behaviour (Staudt et al. 2019) and on innovative energy market designs (Staudt and Oren 2020).

3.1.1 Support Systems for Energy Consumers

The objectives and preferences of users are always a central component when new coordinating mechanisms and market designs are developed. In this direction, the research group is working on several projects that allow the user to trade electricity locally and in the neighbourhood through IS and with the help of decision support systems (Golla et al. 2020). These support the user in the choice of the electricity rate (Vom Scheidt et al. 2019) and additional investment in infrastructures such as heat pumps or battery storage and help aggregators supply micromarkets at minimal costs with the use of available resources. The group is working at the interface of energy market research, green information systems and energy informatics, especially energy data analytics (vom Scheidt et al. 2020). Throughout these disciplines, the

research is driven by an engineering approach in the design of markets, mechanisms and information systems which are then evaluated through simulations and field and laboratory experiments (Staudt et al. 2019). This way, the research group develops artefacts that support the energy transition as a whole. The results are currently applied in two major projects which is the development of citizen energy communities in three neighbourhoods in Landau and Ettlingen and through a battery storage research project in Baden-Württemberg. These projects already announce future trends in electricity market research.

3.1.2 Innovative Energy Market Designs

Citizen energy communities are promoted by the European Union as a way to have citizens participate in the energy transition (Golla et al. 2020). The according regulation will allow new solutions to trade and share locally produced electricity. This is an important research and business area that will support local suppliers and thus add to a further decentralization of the power sector. Furthermore, electric vehicles are finally entering the market in large quantities. This trend will be further intensified as charging infrastructure is added (Schmidt et al. 2020). Simultaneously, the prices for storage are decreasing, and production is becoming more environmentally friendly. This adds significant flexibility to the electricity system that needs to be coordinated. Finally, deep decarbonization is only possible through hydrogen electrolysis which will greatly change the electricity system as a whole. The development of market mechanisms and information systems according to this trend will take centre stage over the next decade. This further includes algorithms that support the coordination of the electricity system and grid to improve the integration of renewable generation and large loads added by hydrogen electrolysis. Data analytics and artificial intelligence will thus play a major role in future decarbonization of the electricity system.

3.2 Business Data Analytics

The topic of data analytics or science, especially in connection with big data, has increasingly become a focal point of public attention. Behind the great popularity of the topic is the fact that today more data than ever is available to support decision-making. In this context, data science explores the extraction of knowledge from mostly high-dimensional and heterogeneous data. The research group Business Data Analytics (BDA) aims to create value for businesses and society from the opportunities created by (big) data analytics and, in particular, methods within the broader terminology of artificial intelligence (AI).

In recent years, the BDA group has primarily worked on developing methods and models that allow for more precise, faster or valuable utilization of vast amounts of heterogeneous and unreliable data. In doing so, the research group has

explicitly focused on subjects like the development and combination of analytical methods with forecasting models (Blanc and Setzer 2016), the development of novel analytical approaches in the context of geographic IS (Wiener et al. 2016) or the modelling and prediction of user behaviour based on heterogeneous field data (Schoch 2016).

At present, the group focuses its research on three major trends that have become critical for businesses looking to achieve competitive advantage through data science. The first trend is the search for qualitative improvements in recommendation systems (RS) that includes method hybridization and comprehensive analyses not only of the functionality of RS but also of their impact on socio-economic variables. The second trend is the development of interfaces and mechanisms to enable the exchange of data through markets or platforms, for example, through the process of incentive engineering. The third trend is the prediction of financial assets through innovative AI models and methods.

3.2.1 Recommendation Systems Innovation

RS have become commonplace in the digital landscape, perhaps best known from retail platforms like Amazon or Netflix, where customers receive daily recommendations for content that could be of interest to them. RS classify the usefulness that users attribute to individual items. To create these classifications, RS can be designed using different paradigms (e.g. collaborative filtering or content-based filtering). The combination of different RS paradigms to so-called hybrid RS can outperform individual approaches but requires an appropriate weighting of the individual RS. Available error data of individual RS allows finding an optimal weighting for each individual RS, which minimizes the accuracy of the hybrid RS. It can be shown that such hybrid RS outperform the results of the individual RS (Haubner and Setzer 2020).

In addition to methodological research on RS, the research group also conducts research to study RS from a socio-economic perspective. In particular, the existence of news RS embedded in major social networking platforms such as Facebook or Twitter has had an increasing influence on when and, above all, which news we consume. The resulting debates about emerging filter bubbles, in which individuals are continuously confronted with messages that confirm or reinforce their opinions, have gradually turned the role of RS into a socially highly relevant matter. Questions are raised as to whether RS can lead to increased polarization or even radicalization. Against this backdrop, research on responsible news RS examines whether and if so which configurations or paradigms of RS can lead to such filter bubbles. In doing so, guidelines for responsible news RS will be developed, which explicitly avoid these filter bubbles.

3.2.2 Data Markets and Platforms

Virtually all data analysis methods have one common demand: to achieve an adequate quality of modelling, the availability of large and accurate data sets is essential. In reality, however, this is often not guaranteed. There is either a lack of sufficient data to train meaningful models or the quality of the available data is insufficient. Therefore, the research group investigates the potential of combining high quality with swarm-based mass data in the form of open data crowdsensing services. Within this work, large training data sets are generated and published to reduce investment thresholds for future actors or start-ups and, thus, create the basis for innovative solutions. Furthermore, the use of these data sets and their future enrichment will be realized via a framework with a connected marketplace platform.

In business domains, the demand for data can be achieved by collaboration among companies within value networks. Within these networks, operators are often still acting too isolated and reserved concerning data availability, which, in turn, obstructs the creation of value. However, once all network partners follow a holistic perspective and act as one data-sharing entity, competitive advantages can be achieved (Badewitz et al. 2020). In the work on the management of collaborative value networks, it is investigated how companies and value networks can contribute to the overall performance of the network through data sharing. For this purpose, Industry 4.0 concepts are further developed into digitized collaboration tools, considering economic, security and data protection aspects. The availability of such cross-company data also opens up new data-driven business opportunities. In a complementary effort, together with industry partners, current research is investigating the potential of new business models derived from the Caruso data platform.[2] The platform harmonizes sensor data from vehicles of various international car manufacturers and provides access to in-vehicle data, which enables, for instance, new insurance concepts (pay-as-you-drive), services for workshop access or sharing concepts (e.g. car sharing).

3.2.3 Modelling Asset Development

The release of the digital peer-to-peer cash system Bitcoin in 2008 popularized the blockchain with its three key components: secure information transfer leveraging cryptographic protocols, a distributed database and a decentralized consensus mechanism. Since then, Bitcoin has become more and more popular. In 2019, Bitcoin already had a market capitalization of more than US$155 billion; this trend is steadily increasing. This success has already led several researchers to consider Bitcoin as a new asset class. However, the novelty of Bitcoin in the landscape of cash systems raises questions about which methods are suitable for analysing the Bitcoin market. Simultaneously, a literature review has shown that existing research

[2] https://www.caruso-dataplace.com/.

streams are currently not yet in a mature state. Existing approaches are difficult to compare and lack a scientific level of transparency and reproducibility (Jaquart et al. 2020a). Therefore, the BDA group is currently pursuing a research endeavour in which Bitcoin market's predictability is investigated using a variety of machine learning methods. For this purpose, both the methods and models identified in the former literature review article and so far unused state-of-the-art methods are being tested using various feature sets. So far, it can be shown that machine learning models can predict the market to a certain extent. Although within this study a first trading strategy cannot compensate for arising transaction costs, the proportion of explainable variance nevertheless encourages further research in this context (Jaquart et al. 2020b).

3.3 Electronic Markets and User Behaviour

Experiential and behavioural processes have become a central topic in human-computer interaction and IS in the last decade, especially in the context of digital system and platform use (Knierim et al. 2017b, Lux et al. 2018, Peukert et al. 2018b). This is due to an emerging consensus that aspects like emotion, motivation and trust critically interplay with decision-making quality and with individual and social functioning. For example, emotions have been determined as the cause of both irrational behaviour (Adam et al. 2011, Jung and Weinhardt 2018) and high-quality decision-making (Hariharan et al. 2016, Lux et al. 2018). Emotional salience and management have been considered a vitalizing and conflict-moderating aspect in digital participation platforms (Lux et al. 2015a, Peukert et al. 2018b) or a driver of small group performances and interaction satisfaction (Knierim et al. 2017a). Trust on the other hand has been identified as a central driver of readiness for economic transactions (Hawlitschek et al. 2016, Peukert et al. 2018b), and trust-facilitating systems have shown a clear competitive advantage for companies operating in the so-called sharing economy (Dann et al. 2020b; 2019). The research group Electronic Markets and User Behaviour (EMUB) dedicates its work to improving the understanding and design of digital systems that improve individual and social experiences in everyday life.

The basis for this (primarily experimental) research was established with the creation of the KD^{2}Lab. For more details on the lab's history and characteristics, see Hoffmann et al. (2021) in this book. In recent years, research emphasis of EMUB has, for example, been placed on the impact of choice architecture (nudges embedded in a system interface) on improved decision-making quality by reducing decision inertia in the context of computer-driven consumer investment decision (robo-advisory) (Jung and Weinhardt 2018) or on the value of including feedback on emotional states in real time to reduce irrational behaviour in financial decision-making (Astor et al. 2013, Lux et al. 2015b). A particular stream of research has focused on the effect of user interface design elements on the facilitation of trust in the sharing economy. Peer-to-peer sharing platforms differ from traditional e-

commerce in the aspects that private individuals typically run both sides of the transaction (and not established corporations) and that part of the transaction can take place in "real" life (e.g. booking an apartment on Airbnb) (Dann et al. 2019). In this context, mutual trust has emerged as a fundamental transaction facilitator. Research in the EMUB group has identified that the manipulation of design aspects (e.g. profile pictures, star ratings, text reviews) decisively influences users' decisions to enter into a transaction on a peer-to-peer platform through both economic and social aspects (Dann et al. 2020b). Furthermore, studies identified that even the technological foundation of the platform itself impacts transaction intentions, for instance, because the blockchain's reputation as a "trust machine" is reflected in the perception of specific user groups (Dann et al. 2020a). Another stream of research has focused on leveraging multimodal data streams during IT system utilization to develop insights and models for improving user experiences in the context of knowledge work. In particular, neurophysiological data that can be collected continuously (through sensors worn on the body) has been utilized to build an understanding of how individual and social experiences can be unobtrusively detected in real time. Examples of this work are the research on using heart-rate analysis and feedback in small group interaction to improve intra- and inter-individual emotion management during teamwork (Knierim et al. 2017b;a) or the research on neurophysiological correlates of flow experiences (Knierim et al. 2019a; 2017c; 2019b). Especially the latter work tackles the challenge of how desirable experiential states (in terms of both individual and social performance, satisfaction and growth) can be observed and eventually facilitated.

At present, the research group focuses its research and education on two major trends in the context of digital system use that are becoming critical due to increased technological availability, ubiquity and sophistication. On the one hand, this refers to the increased demand for complex knowledge work due to advances in AI technology and how such complex work can be supported through IT-based system-enabled affect detection. On the other hand, this refers to the requirement of leveraging data-driven methods that are able to extract meaningful insights and predictions from diverse multimodal sensor data.

3.3.1 Affective Experience in Knowledge Work

Demands for unstructured knowledge work (KW) are growing, due to the rise of AI technologies that are replacing repetitive work in sales, administrative support or service tasks (Frey and Osborne 2017). As KW is by its nature complex and highly task- and situation-specific, it rarely comes with a single way of completing it. Additional developments, including flat hierarchies, self-directed work, job-crafting, open offices and digitally mediated collaboration, further extend this KW complexity (Bakker and van Woerkom 2017). Therefore, systems that aim to support KW are faced with the challenge of providing person-, task- and situation-independent approaches. A promising approach for this endeavour is the development of systems that support experiences, not specific tasks. To this

extent, current projects are, for example, focusing on how flow experiences can be unobtrusively detected in individuals and small groups in the KW context (e.g. during the process of scientific writing) (Knierim et al. 2019a;b) using ECG and EEG measures and behavioural recordings (mouse and keyboard input). In another instance, research projects are investigating how comfortable wearable sensors can be used for recordings in more externally valid experimental scenarios and how these sensors can be used to track multiple physiological processes at once (e.g. extracting the ECG signal from an EEG recording). Furthermore, the integration of covert (i.e. physiological) and overt expressions of emotions (i.e. facial activity) into models that track affective experiences represents an effort that aims to enable more robust models that affect-adaptive systems can rely on.

3.3.2 Methods and Models for Adaptive Systems

Observing behavioural and neurophysiological data in real-world settings offers exciting possibilities like the support of physical health and mental well-being and the introduction of novel human-computer interaction modalities. The development of such applications is, however, strongly impeded by measurement complications in terms of internal validity, acquisition frequency and robustness and intra- and inter-individual variance. For example, while it is still often believed that physiological sensors provide objective measures of internal states (perhaps even unbeknownst to the individual), nowadays, it is a more common view that many derived features are multiply determined and that adaptive systems require large amounts of data (per person, per sample and per measurement domain) that allow differentiating meaning from noise in the observation. Therefore, research on methods and models for adaptive systems is currently moving towards more sophisticated and inductive analytic methods. This primarily includes the use of feature selection methods that allow identifying various shapes of variable relationships (e.g. using the maximal information coefficient to detect non-linear bivariate relationships; Reshef et al. 2011) and the use of transparent classification methods like explainable AI (XAI) (Gunning et al. 2019) that not only allow development of useful classifiers for adaptive systems but also provide insight into which features generated from sensor data meaningfully inform such classification outputs. Together these research efforts aim to enable the development of IT-based adaptive systems for the future of knowledge work that are able to support affective experiences in their natural context, in real time, so that positive individual and social experiences can be facilitated.

3.4 Digital Experience and Participation

Today's life is characterized by constant interaction with digital devices and systems, which affect almost all facets of our daily routines. The technological progress

is—now for a considerable time—no longer only noticeable on a business level, but also in our private lives, digital devices have developed as permanent companions that continuously feed us with information of various kinds. Due to this ubiquity of digital devices, it is of utmost importance to investigate how users interact with these technologies, both on an individual and group level. One prerequisite, however, for people adopting these new technologies is that they demand a comprehensive digital experience. The term digital experience can be described as the resulting experience from the composition of multiple devices, digital artefacts or modes of interaction. Basically, it can be understood as the combination of separate user experiences to an overarching experience driven by digital technologies or services. Together, the activities of the research group Digital Experience and Participation (DXP) focus on the investigation of technology acceptance and digital experience, always with a strong emphasis on emerging digital technologies and interaction modalities.

In the past, the research group has primarily worked on understanding and designing the experience of digital technology users and subsequently supporting users to better capture, understand and process information and by doing so enable empowered decision-making. Specifically, this work has targeted the analysis of the decision-making process in different shopping scenarios, e.g. online, offline and virtual, and thereby also applied eye-tracking technology (Peukert et al. 2020, Pfeiffer et al. 2020). Furthermore, the research group has investigated how humans experience the interaction with others and with the underlying technology on participation and collaboration platforms. Here, it has been of importance to create a better understanding of how participants evaluate and consolidate proposals in participation processes through (feedback) mechanism design (Niemeyer et al. 2016, Wagenknecht et al. 2018), and how platforms and mechanisms need to be designed to incentivize actions that promote greater societal welfare (Straub et al. 2015). Moreover, the transfer of these participatory approaches to institutional and governmental processes paves the way for digital participation also for firms and public institutions. Firms, for instance, may take advantage of the crowd's wisdom in open innovation processes. However, when implementing, it is important to provide the right incentives, suitable rating scales, and to further reflect on the trade-off between anonymous and pseudonymous participation formats (Wagenknecht et al. 2017b;a).

At present, the research group focuses on two emerging trends that can be described as novel user experiences in immersive systems and as the pervasion of participatory and collaborative systems and its ensuing challenges. These developments are driven by emerging changes in the digital technology landscape, specifically the increased availability of immersive systems and the ubiquity of mobile-ready platforms. These changes have altered how people operate platforms or take part in markets, opening up entirely new ways to experience and participate. First, through the advent of immersive systems, the nature of how we interact with IS may switch to new forms generating an unprecedented digital experience. Advantages of these new interaction patterns, visualization techniques, sensory modalities and general potentials through an increased degree of immersion can, e.g., be used for behavioural change systems. Second, through participatory and

collaborative IS, users of such systems are not only consumers but prosumers. While this might not be a new trend, to some extent this is true since the advent of the web 2.0; it is now used in a wide variety of societal, political and business-relevant contexts. Also, new trends such as digital citizen science open up challenges and blur boundaries between the offline and online world.

3.4.1 User Experience in Immersive Systems

Immersive systems have been around for quite some time, but only recently they have attracted much attention in IS research. Among others, the reasons for the raised attention are advances in and falling prices of the technology and the accompanying entry in the end-consumer market. The research activities of the chair mainly focused on VR shopping environments (Peukert et al. 2018a; 2020; 2019a;b, Pfeiffer et al. 2017). Various questions concerning the acceptance of VR shopping environments were addressed (Peukert et al. 2019a;b), but also how user assistance systems for virtual shopping environments can be designed (Peukert et al. 2018a; 2020, Pfeiffer et al. 2017). In particular, the concept of detecting different phases in consumers' decision-making process based on real-time analysis of eye-tracking data was introduced, aiming at designing context-aware user assistance systems (Peukert et al. 2020). Besides the application of immersive technology in a shopping context, first attempts have been made to observe how immersive experiences influence behaviour, in particular donation behaviour (Greif-Winzrieth et al. 2020). Moreover, a new stream of research combines immersive systems with e-participation platforms to better visualize information, e.g. how new construction projects will look like when finished, thereby empowering people to participate (Fegert et al. 2020).

3.4.2 Participatory and Collaborative Information Systems

Through lowered entry barriers, i.e. the technological availability and cost-efficiency of development tools, new services have paved the way for an unprecedented opportunity for collaboration and participation in everyday lives. Nowadays, people communicate via online messengers and apps, collaboratively build knowledge databases, work on crowdsourcing platforms, fund companies with capital gathered on crowdfunding platforms, develop new products in open innovation contests, make collaborative predictions on uncertain future events in prediction markets and Delphi markets and take part in political debates and decisions via online polls, discussion boards, e-participation platforms or participatory budgeting programmes (Fegert et al. 2019, Kloker et al. 2017, Niemeyer et al. 2016, Straub et al. 2014; 2015; 2016, Wagenknecht et al. 2017a). Now, a new wave of digital participation processes is being investigated and designed, which are primarily intended to enhance public participation in local government processes, e.g. urban planning or construction projects. For instance, within the research project Take Part, the

implementation of the emerging technologies Augmented and Virtual Reality into e-participation is studied in several use cases around Karlsruhe investigating whether the application of immersive systems increases the overall participation in public projects (Fegert et al. 2019).

Lastly, the understanding of the integration of participatory approaches into platform design leads to a new field of application: Digital Citizen Science (Weinhardt et al. 2020). In contrast to classical citizen science approaches, the public might participate in research not only by providing or gathering data but that they might be empowered to actively contribute to science through formulating their own research questions, developing their own hypotheses and finally discussing those transparently and interactively with other citizens and researchers.

4 Concluding Thoughts

As IT-based systems are more fundamental and interconnected with everyday private and professional lives, with individual, social and institutional experiences and processes, the research that forms the basis for our understanding of how these systems develop and shape our lives is more pressing than ever before. While these systems are presently demonstrating difficult challenges, they are also amply demonstrating potentials to shape our present and future positively. IT-based systems offer unprecedented potential to improve societies and human lives through democratic empowerment (e.g. through digital participation in governmental decision-making), ecological sustainability (e.g. through information and market access related to the ongoing energy transition) or data-driven economic and technological innovation (e.g. through the identification of unknown insights in large and heterogeneous data). Hopefully, through this short review of how the scholastic work at the IM chair is tackling relevant issues and advancing promising developments, this chapter has presented the interested reader with a glimpse into the ongoing work in IM research groups and the overall developments in contemporary IS research.

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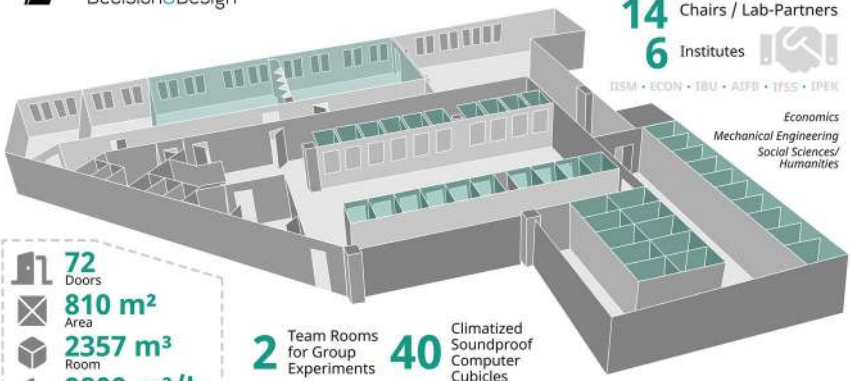
KD²lab
Decision&Design



14 Chairs / Lab-Partners

6 Institutes

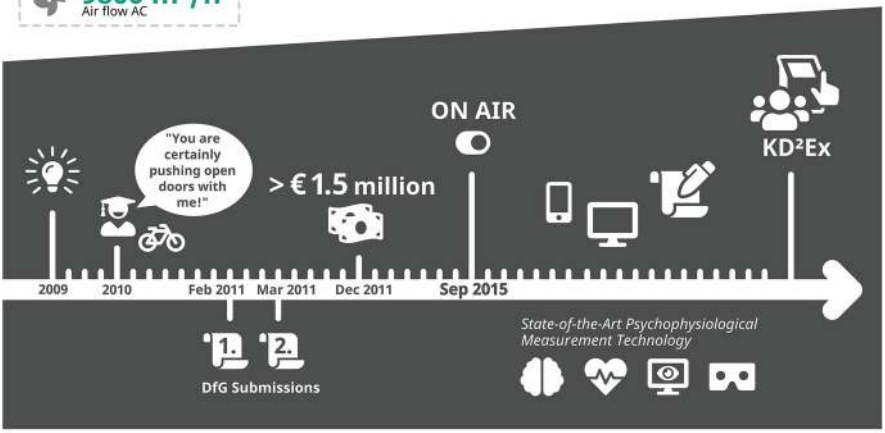
IISM • ECON • IBU • AIFB • IFSS • IPEK

Economics
Mechanical Engineering
Social Sciences/ Humanities

72 Doors
810 m² Area
2357 m³ Room
9800 m³/h Air flow AC

2 Team Rooms for Group Experiments

40 Climatized Soundproof Computer Cubicles



Experiments

170
2015 - 2020

*State: Sep. 2020

65 Experimenters
1271 Bookings
2207 Sessions
20 Graduations
26.807 Participations
239 max. per day

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