The Future of Information Systems in a Post-COVID World by TC8 (Information Systems)

Isabel Ramos[1(✉)], Dale Mackrell[2], Alta van der Merwe[3], Jan Pries-Heje[4], Jolita Ralyté[5], Janis Stirna[6], John Krogstie[7], Matthew Jones[8], Benjamin Mueller[9], Frédéric Adam[10], Bettina Jaber[11], Edgar Weippl[11], Marijn Janssen[12], Amany Elbanna[13], Banita Lal[14], Pierluigi Plebani[15], Allen C. Johnston[16], and Li Da Xu[17]

[1] University of Minho, Campus de Azurém, Guimarães, Portugal
iramos@dsi.uminho.pt
[2] Institute for Integrated and Intelligent Systems, Griffith University, Brisbane, Australia
d.mackrell@griffith.edu.au
[3] University of Pretoria, Hatfield Campus, Hatfield, South Africa
alta.vdm@up.ac.za
[4] Department of People and Technology, Roskilde Universitet, Roskilde, Denmark
janph@ruc.dk
[5] University of Geneva, Geneva, Switzerland
jolita.ralyte@unige.ch
[6] Stockholm University, Stockholm, Sweden
js@dsv.su.se
[7] Norwegian University of Science and Technology (NTNU), Trondheim, Norway
krogstie@idi.ntnu.no
[8] Cambridge University, Judge Institute of Management Studies, Cambridge, UK
mrj10@cam.ac.uk
[9] University of Lausanne, Lausanne, Switzerland
benjamin.mueller@unil.ch
[10] Cork University Business School, University College, Cork, Republic of Ireland
fadam@ucc.ie
[11] SBA Research, Vienna University of Technology, Vienna, Austria
eweippl@sba-research.org
[12] Faculty of Technology, Policy and Management, Delft University of Technology, Delft, The Netherlands
M.F.W.H.A.Janssen@tudelft.nl
[13] School of Business and Management, Royal Holloway University of London, London, UK
amany.elbanna@rhul.ac.uk
[14] University of Bradford, School of Management, Bradford, UK
b.lal1@bradford.ac.uk
[15] Polytechnic University of Milan, Milan, Italy
pierluigi.plebani@polimi.it
[16] Culverhouse College of Business, University of Alabama, Tuscaloosa, USA
ajohnston@cba.ua.edu
[17] IT and Decision Sciences, Old Dominion University, Norfolk, VA, USA
lxu@odu.edu

Abstract. This chapter consists of several sections which contain contributions from members of IFIP Technical Committee 8 (Information Systems). We highlight the accomplishments of Technical Committee 8 (TC8) and its working groups over its 50 years history, and then envisage possible strategies for the future of information systems (IS) in a post-COVID world. This chapter begins with an overall view of the diverse and changing roles of the IS field then moves forward to foresee environmental sustainability and digital glocalization in a post-COVID-19 world. Next, we review the achievements of TC8, the establishment of the working groups within it, and predict what TC8 has to offer into the future. Lastly, we identify the individual working groups of TC8 to detail their activities as important conduits of research and practice in the field of IS over the past 50 years, then imagine the roles of the TC8 working groups in a post-COVID landscape.

Keywords: Information systems · Technology · Society · Organisations · Technical Committee 8

1 Introduction

The call for this chapter has come at an opportune time when we have had a chance to reflect on the recent past and try to imagine post-COVID society where the health of humanity and the health of earth are synchronised. We have had glimpses of this synchronization as nations try to curb economic relationships in attempts to suppress the spread of the COVID-19 virus. This incentive has given us hope that climate change may be slowed if we make efforts to reduce pollution levels in local and global responses. The use of technologies has been instrumental during the COVID-19 pandemic as more citizens work and play online and will continue to dominate the focus of research and practice in the information systems discipline in a post-COVID world.

One perspective on post-COVID society is Society 5.0, defined as "a human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space" (https://www8.cao.go.jp/cstp/english/society5_0/index.html). It is called Society 5.0 because it follows the hunting society (Society 1.0), agricultural society (Society 2.0), industrial society (Society 3.0), and information society (Society 4.0). In Society 4.0, the common practice is to gather data from physical space via the Web, store it in the Cloud for analysis by humans. While information may be shared, there are limitations. On the other hand, physical space in Society 5.0 is sensor-driven. People, things, and systems are all automatically connected in cyberspace. Analytical results obtained by artificial intelligence (AI) are fed back to physical space. This convergence of cyber and physical space promises new societal awareness and values.

In this chapter, we begin by looking at the role of information systems (IS) with a focus on environmental sustainability and digital glocalization in a post-COVID world. The next section takes us back to the achievements and publications of Technical Committee 8 (TC8) and the working groups within it. It also lets us see what TC8 has to offer into the future. The final section of this chapter recognises the various working groups of TC8 and specifies their activities as important conduits of research and practice in the diverse field of information systems over the past 50 years and moving forward.

2 The Future of the Information Systems Field

For some time now, scientists have been warning about the climate crisis and its growing impacts on the well-being of human populations. The current health crisis is only one of these impacts and other disruptive events are expected in the coming years or decades. This perspective on the near future has brought to the international agenda the need for a more sustainable and equitable global economic model (Oldekop et al. 2020).

In the face of disruptive events on a global scale, there is a need for local economic and social responses coordinated on a global scale. The impacts of future disruptive events will differ from region to region and require action from local communities adjusted to local needs. On the other hand, these local initiatives must clearly contribute to sustainability goals that must be global in order to slow down climate processes that threaten humanity as a whole. This approach, which some authors already call glocalization (Roudometof 2016; 2019), implies concrete focuses of intervention, namely digital globalisation, green economy and local/global governance.

2.1 Digital Globalisation and Sustainability

The concept of digital globalisation refers to a new form of globalisation in a world increasingly aware of its environmental footprint and the danger it poses to the survival of humanity in the medium and long term. The flow of information has been growing in recent decades, ensuring the interconnection of societies and economies at a global level. The global transmission of ideas, knowledge and innovation has enabled a broad participation in the digital economy, adjusting solutions and recommendations to local needs. Governments, citizens and businesses can participate in digital platforms to access globally generated insights and opportunities. Thus, the digital transformation is becoming a central topic of research, education and practice in the area of Information Systems (Vial 2019).

The growing interest in exploring the opportunities offered by technological advances has to be made compatible with the need to guarantee a sustainable development of economies, which ensures that it protects the planet and ensures the well-being of peoples. In other words, the digital transformation of governments and organisations must create environmental, economic and social value (Wessel et al. 2020). The discipline of information systems is called upon to develop insights, approaches and IT solutions that effectively support value creation. It is also called upon to study how available IT technology applications can be used and interconnected effectively to enhance sustainable development.

2.2 The Centrality of Information in Integrating Local and Global Governance

The adequate response to disruptive events requires strong governance, whether at the level of country, city, organisation or information systems. Decision-makers must have the power to make decentralised decisions that allow them to plan and implement the necessary adjustments to the uncertainty and complexity faced at every moment. In addition to this local response, it is necessary to ensure the agility of businesses and communities, promoting their access to the resources they need to deal with the pressure

of globalisation and the need to maintain the sustainability of their operations. The threats posed by climate change, environmental decline, water scarcity, overpopulation and misinformation, for example, cannot be adequately addressed with only local efforts (Pappas et al. 2018). They require global collaboration mechanisms that (1) equip nations with the efficiency and agility to respond to global challenges, (2) ensure the solidarity needed to tackle problems that emerge from disruptive events and protect the most vulnerable populations, and (3) make nations and institutions accountable for practices, implemented deliberately or not, which put humanity as a whole at risk.

This interconnection between local and global governance that glocalization requires can only be achieved by the proper management of information flows in an increasingly digital world. The digital transformation of society will change the way we live, interact, learn and work. It has also been amplifying problems related to inequality in internet access, the spread of misinformation, online violence, breaches of privacy, digital warfare, among others. The discipline of information systems is thus called upon to contribute to better management of information and technologies at global and local level (Barnes 2020), including through the production of theories and approaches that support (1) the sharing of information between countries and organisations, (2) the design of engaging digital work environments, (3) the creation of value chains resilient to disruptive events, (4) access to health care at an affordable cost to everyone, (5) the reinforcement of responsible consumption behaviors, (6) the provision of education with a high level of quality, and (7) the construction of a safer and more inclusive society.

2.3 Regional Perspectives in Brief on Glocalization and What Technology is Bringing to the Conversation

At a global level, indications are that the great challenges that need global coordination and local action are associated with economic and climate sustainability, with a particular focus on the continued digitization of the economy and energy efficiency.

With regards to the digital transformation of the economy, Europe is committed to the empowerment and inclusion of citizens, as well as strengthening the capacity of companies to deliver value in the global market. Regarding energy efficiency, the focus is on reducing greenhouse gas emissions and a strong investment in renewable energies (Demertzis et al. 2019). To address the challenges in these two areas, the coming years will bring a significant investment in research, education and innovation. Universities play a crucial role in creating and transferring knowledge essential to strengthening the economy; mechanisms such as science and open innovation will continue to be the pillars of the strengthening of University-Citizen and University-Industry links.

In the United States, these concerns are compounded by the challenges of maintaining its place as the greatest economic and military power. These challenges will bring increasing investment in disruptive technologies and businesses. The desire to reduce dependence on global value chains could reinforce efforts to reintegrate processes and promote regional supplies.

The Asia and Pacific region is very dynamic; the countries of the region show substantial differences in terms of socioeconomic status, physical and population dimensions, and climatic zones. Thus, these countries face similar and/or very different challenges, which makes it even more important to define a glocalized agenda. Some of the common

challenges include reducing inequalities across the Asia and Pacific region, improving the environment, stimulating employment, deepening democracy and social cohesion, managing regional and global political and economic relations, among other challenges.

A similar diversity can be seen in Latin America (de Sanfeliú et al. 2020). The countries of that region of the globe are quite different in terms of size, populations and level of development. Although decreasing in the last decade, poverty and inequality are still very present in the region. Corruption is also a serious problem in these countries, limiting their ability to become strong economies. To address these regional challenges, citizens need access to better public services and social justice. The digital transformation of governments can be central to restoring confidence, enabling agile governance and advance smarter regulation.

Africa continues to face serious difficulties in improving living standards across the continent. The dependence on regional institutions for external financing and the difficulty in ensuring continental integration expose the continent to international exploitation and frequent internal conflicts. Informal workers represent 86% of total employment in Africa (Hevia and Neumeyer 2020). This situation highlights the importance of supporting and developing the informal economy, accelerating continental integration, namely through the adoption of transnational technological infrastructures, and ensuring the centrality of food systems. Food systems can benefit greatly from the applications of information technologies, including Internet of Things (IoT) and Artificial Intelligence (AI). Information technologies have allowed the creation of high productivity services and agribusiness. In addition, infotech, biotechnology and fintech may contribute to solving some of the structural problems faced in Africa (Coulibaly 2020).

2.4 IS Research and Education for a Glocalized World

The information systems discipline should reflect this diversity of challenges and technological needs in order to produce knowledge and develop relevant innovations locally, while observing the scientific rigor inherent in a global discipline.

The principles, practices and processes that are widely applicable will naturally be part of IS education and research globally. They allow for the development of sound knowledge and skills required to assist in the digital transformation of organisations and society. Still, the development of knowledge and innovations based on local phenomena with relevance to a particular community, region or country should be encouraged and valued in a glocalized approach to the discipline. The global sharing of knowledge and technologies is fundamental to the development of the IS discipline. However, their application in a way that is sensitive to local conditions is central to address the complexity of innovation systems and, therefore, the continued relevance of the discipline (Martinsons 2016).

3 The Future Role for TC8 Drawn from the Past

Information Systems (IS) emerged as an independent field in the 1960s based on an interest in organisations and people using computers for business processes. From the beginning, most IS research was quite management-oriented and dominated by quantitative

research methods. The first major journal focusing on IS was launched in March 1977; Management Information Systems Quarterly (MISQ). The Information Systems research seminar in Scandinavia (IRIS) began in 1978 and is today the oldest IS conference in the world still running every year. The first international conference on Information Systems - ICIS - was held in Philadelphia, USA, in 1981.

Through the eighties, the IS field was characterised by strong growth. Many universities around the world created an institute or a department of IS. In the USA and UK, the majority of IS research was located in business schools. In Europe, IS was often located together with natural sciences or the humanities.

Ahead of this growth, in 1974, the Technical Committee 8 under the International Federation for Information Processing (IFIP) was approved. Shortly afterwards, the first two working groups (WG) were established: WG8.1 Design and Evaluation of Information Systems and WG8.2 Interaction of Information Systems and the Organisation. Hence, from this time TC8 had a dual focus on design and development on one side and on application and utilisation in organisations on the other side. In fact, one could say that this dual perspective on design and use is still the core of TC8.

In the 1980s, and especially after the introduction of the personal computer (PC), Human-Computer Interaction came on the agenda. Many studied the correlation between user friendly IT systems and satisfaction with the same systems. One of the most cited models was the Technology Acceptance Model (TAM) that says that acceptance of new IT depends on the perceived usefulness, the perceived ease of use, and the user acceptance.

In the 1980s, three new TC8 working groups were established, with two of them focusing on specific types of IT systems. In 1981, WG8.3 Decision Support Systems was established. This group focused both on a special kind of systems – decision support – and on a specific business process – decisions. This is still an important task for TC8 to take on when some new technology comes around. For example, for smart cities we can study how they are designed and discuss how and what technology to use. Further, we can look at the business processes within smart cities and how they best utilise new technology to create digital transformation.

The other group initiated in the eighties was WG8.4 Office Systems that a few years later changed their name to WG8.4 E-Business Information Systems, again focusing on new technology in the years where E-business was invented and on how this new technology was applied and utilised. This emphasises that TC8 often has tried to take a leading role when new technology was introduced in businesses and organisations. Typically, TC8 working groups operate through organising working conferences. Often these conferences have set the stage for new and existing research that later after some maturation has become part of mainstream research and practice.

The third group initiated in the eighties was WG8.5 Information Systems in Public Administration. The new thing about this group was that it concentrated on a specific area of society, namely, the public sector.

The 1990s brought increased awareness about IT systems for collaborative support and knowledge management. In 1994, the Association for Information Systems (AIS) was founded as an organisation for academics specializing in information systems. AIS did not seek to interfere with or replace IFIP. In the late 1990s, a wave of internet and

web applications led to much interest and research in these areas. In the 1990s, WG8.6 Transfer and Diffusion of Information Technology was approved in 1995. This group combined the two original areas of TC8, design and use, in that it looked at design in the context of the organisational change or implementation of technology.

WG8.7 Informatics in International Business Enterprises became something of a non-starter. No working conferences were held by WG8.7 and the group disappeared after a few years. In 1998, WG8.8 Smart Cards was approved. This group was a bit like 8.3 in that it concentrated on a very specific technology but this time they looked at the use of this specific technology in all kind of business processes. Like WG8.7, WG8.8 is also no longer functioning.

In the new millennium, WG8.9 Enterprise Information Systems was approved in 2005. Again, this group looked at a specific technology that had gained widespread use and researchers discussed the potential. It also provided a critical angle. In 2008, a working group with a shared focus on security was established with TC11. This was WG8.11 Information Systems Security Research. This group had a special purpose in that they were not meeting to present papers published in proceedings by IFIP. Instead, they were meeting with the purpose of writing and improving papers for the very best journals in the field of IS security. Shortly after in 2011, WG8.10 Service-Oriented Systems was established together with TC2 and TC6. Finally, in 2019, the latest working group, WG8.12 Industrial Information Integration was established.

Based on this impressive history, a natural question to ask is how TC8 can inform a strategy for the future? The answer, we believe, is to stick to what TC8 in the past has been good at. First, that could be to maintain the dual focus on design and development on one side and on application and utilisation in organisations on the other side. Second, focusing on new special kinds of Information Systems and the specific business processes. An important example was mentioned in the prior section, digital transformation. Third, TC8 can focus on the use of IS in specific areas of society. For example, in the public sector worldwide there is a growing focus on Smart Cities and Green Sustainability. This can be picked up by an existing working group such as WG8.5 or it can be addressed by a new working group. Time will tell. But no matter what, you will also find TC8 at the forefront of the newest technical development in Information Systems in the future.

4 The TC8 WGs Perspectives

IFIP TC8 was established by the International Federation for Information Processing in 1976 as a Technical Committee dedicated to the field of Information Systems. TC8 aims to promote and encourage the advancement of research and practice of concepts, methods, techniques and issues related to information systems in organisations. TC8 has established eight working groups (WG), the history and activities of which are described below. In addition to the activities of its working groups, TC8 also organises working conferences and publishes books through IFIP. TC8 holds an annual National Representatives meeting.

WG8.1: Design and Evaluation of Information Systems
Established at the creation of TC8 in 1976, WG8.1 is focused on the planning, analysis, design and evaluation of information systems. The aim of the group is threefold:

(1) to define relevant concepts and theories, (2) to develop languages, techniques, tools and methods for applying these concepts and theories, and (3) to develop method engineering approaches for the analysis, construction and evaluation of information systems development methods and tools.

For over forty years the WG8.1 members have contributed to the development and evaluation of modelling languages, techniques, tools and methods for information systems engineering, evolution and assessment. The themes of the conferences and workshops organised reflect the evolution of their research ambitions, from defining the foundations of the field to exploring new trends and shaping new approaches and paradigms. In April 1979, WG8.1 held its first working conference in Oxford on "Formal Models and Practical Tools for Information Systems Design". Then, WG8.1 held two working conferences in 1982, one on each side of the Atlantic. The last of these conferences was the first of a series of so-called CRIS conferences which were collectively part of an in-depth comparative review of information systems methodologies.

The task group FRISCO was established in 1988 with the aim to develop a reference background comprising a consistent and fully coherent system of concepts and a suitable terminology for scientists and professionals in the information systems area. The "Framework of Information System Concepts" (Falkenberg et al. 1998) developed by this group is one of the significant contributions of WG8.1 to the development of a scientific outlook on the field of information systems. The group organised three working conferences on the subject (ISCO1 in 1989, ISCO2 in 1992, ISCO3 in 1995) and published the final report in 1998. The report has initiated an important debate and was a key driver for further research in the field. The ISCO conference series was concluded by ISCO4 in 1999.

The early nineties were marked by the emergence of methods and process models for information systems development. The group held two working conferences on this subject: "Information System Development Process" (Como, Italy 1993) and "Methods and Associated Tools for the Information Systems Life Cycle" (Maastricht, Netherlands 1994). The emergence of Internet technologies has brought new opportunities and challenges to the development of information systems, and was acknowledged with two working conferences: "Information Systems in the WWW Environment" (Beijing, China 1998) and "Engineering Information Systems in the Internet Context" (Kanazava, Japan 2002). The way of building new methods for the development of information systems has evolved from the simple ad-hoc method construction to engineering approaches of situational and domain-specific methods. The working group has been actively involved in the development of method engineering theories, approaches and tools allowing to reach a high degree of flexibility and adaptability of methods. Three method engineering conferences took place: "Method Engineering: Principles of Method Construction and Tool Support" (Atlanta, USA 1996), "Situational Method Engineering: Fundamentals and Experiences" (Geneva, Switzerland 2007), and "Method Engineering: Engineering Methods in the Service-Oriented Context" (Paris, France 2011).

The working conferences were meant to be relatively small and focused. To bring together a larger number of researchers, some of the central people in WG8.1 started in 1989 the CAiSE conference series, which today is an A-level conference with international reach. The longest lasting event of WG8.1, with 25 editions already, is EMMSAD

– a working conference on "Exploring Modeling Methods for Systems Analysis and Development" that all the time has been an associated event to CAiSE conferences. Today EMMSAD invites contributions on a large spectrum of topics, including foundations of modelling and method engineering, methods and modelling approaches for specific fields and purposes (enterprise, business, capability, process, ontology modelling), novel approaches to information systems development, domain specific modelling and various aspects of method evaluation. EMMSAD publishes joint Springer Nature LNBIP proceedings together with the "Business Process Modeling, Development and Support" (BPMDS) working conference. BPMDS has also been a WG8.1 event during the last decade and is associated with CAiSE.

In 2008 WG8.1 established a working conference on the "Practice of Enterprise Modeling" (PoEM). Its mission is to provide a dedicated forum where the use of enterprise modelling in practice is addressed by bringing together researchers, users, and practitioners. PoEM proceedings are published by Springer Nature LNBIP series. PoEM also aims to mix paper presentations with hands-on modelling and discussion sessions. In recent years it has featured accompanying events such as doctoral consortium, Forum of emerging ideas and demos, as well as several workshops. Usually about a quarter of the participants come from industry which makes discussions on emerging challenges as well as new methods and tools particularly insightful. In 2020, the 13th PoEM was organised by Riga Technical University, Latvia and due to the travel restrictions imposed by the pandemic it was held remotely.

WG8.1, drawing from its broad group of members, engages in a multitude of research areas following the group's objectives and focus. The rest of this section discusses some of the emerging trends and areas of concern.

The ongoing digital transformation of all areas has led to the need to involve everyone in organisations and society in the development and evolution of information systems, and thus to the need of representing knowledge of all relevant areas in an understandable way. Although some model-driven approaches such as Model Driven Development are successful in the development and evolution of the technical systems, the possibility of visualising the complete information system as done in enterprise modelling is believed to be even more important in the future.

Since recently many modern IT solutions have started to incorporate Big Data and AI-based solutions and components. This offers many opportunities and brings challenges. A recent survey on expected outcomes from using AI in business were "to improve and/or develop new products and services; achieve cost efficiencies and streamlined business operations, and to accelerate decision-making." (EY 2018). At the same time, AI also raises fundamental concerns regarding its social and economic impact, including ethics, security, privacy and trust. These issues were discussed from the point of view of enterprise modelling at a panel session of PoEM 2019 (reported in Snoeck et al. 2020). A first conclusion from the panel discussion is that, with the advent of AI, the need for traditional data management increases rather than decreases, which makes it more important than ever to include data related aspects in enterprise modelling activities to support the alignment of the business and data-driven solutions. It is important to consider data from a traditional data management perspective, but it is also important to include additional concerns, such as data ownership, ownership of "the original"

phenomenon represented by data, i.e. privacy, ethics, biases. Another significant aspect is design for AI – providing foundations for proper data management, by offering means in terms of methods and tools for the design of enterprise-ready AI based solutions. A key aspect of such solutions would be the support for by capturing and analyzing the business motivation and needs for them. Data can also benefit organisational and IS designs and operations. To this end, the emerging development approaches need to make a distinction between "design models" that portray (parts or aspects of) a possible future/desired state of affairs of an enterprise, and "observational models" that portray (parts/aspects of) the current/past affairs of an enterprise and its information systems at runtime.

The future IT landscape will include more and more AI-driven autonomous actors that collaborate with humans. Modern enterprises increasingly involve a hybrid mix of human and digital agents on a large scale, for example, in the context of Industry 4.0. It therefore becomes relevant for emerging methods and tools to embrace lessons learned in the multi-agent systems community.

We also recognise that AI solutions run the risk that over time they turn out to be "digital asbestos" - initially seen as suitable and efficient for the intended purpose, but harmful once the impact and side effects of the application have accumulated. The health hazards of asbestos were discovered only many years later and currently the impact of AI-based solutions has not been studied in depth. Such impact studies should address breadth, i.e. the whole ecosystem in which they operate. Modelling techniques, being a core topic of WG8.1, can be used to better chart out the (potential and materialised) impact of AI. Furthermore, AI solutions need to be designed and implemented in context. This implies, they must comply with the regulations (and ethical norms) of the socio-technical environment in which they set to operate.

The challenging times of a pandemic has led many companies to strengthen their approach to information system portfolio management with an increased emphasis on resilience - the ability to function, to deliver business value, despite adverse circumstances. Due to the ubiquity of IT as a result of the digital transformation, resilience has also been increasingly important independent of the pandemic. Resilience management goes beyond the more traditional areas of concern addressed by cybersecurity because it requires a holistic approach to business and information system design in its context as well as management with respect to often unforeseen changes in the business environment. The complexity of this endeavor is influenced by the high degree of diversity and interconnectedness of the actors involved, which calls for digital ecosystem thinking supported by modelling methods and tools.

WG8.2: The Interaction of Information Systems and the Organisation

WG8.2 was originally established by IFIP in 1977. Over subsequent years, it has played a major role in the methodological and theoretical development of the Information Systems field and in enhancing the field's receptivity to ideas from other social science disciplines. While this may reflect the early contribution of European scholars, especially from Nordic countries, in instituting a distinctive intellectual tradition, over time the group has emerged as a key hub of the international community of IS scholars concerned with the broader social and organisational context of information system development and use. The methodological contribution of WG8.2 was established relatively early

in the group's history, with the 1984 Manchester conference being widely recognised as having played a major part in promoting the acceptance of qualitative methods in IS research. Methods—not exclusively qualitative but also critical, design science, and practice-driven—have remained a core concern of the group with a number of working conferences, in Copenhagen (1990), Philadelphia (1997), Idaho (2001), Manchester (2004), Tampa (2012) and Dublin (2016) adopting a specifically methodological focus.

Although, with the exception of Auckland (2014) and San Francisco (2018), the group's working conferences have generally not predominantly addressed particular theoretical approaches, WG8.2 has been an important venue for early discussion of a number of social theories in the IS field, including Structuration Theory, Actor Network Theory, and Sociomateriality. Members of the group have also been influential in advancing these debates in the IS literature. Reflecting this openness to new theories and perspectives, a number of keynote speakers at WG8.2 conferences have come from other disciplines, including computer science, anthropology and science studies.

This openness, combined with the group's methodological and theoretical heritage, provides an important foundation for addressing the challenges and opportunities posed by the increasing ubiquity, interdependence, and performativity of digital technologies in organisations and society. The hopes and fears evoked by digitalization were specifically explored in the 2018 San Francisco conference under the title of "Living with Monsters" (Aanestad et al. 2018). Issues such as algorithmic decision making and their implications in domains such as predictive policing and automated warfare were discussed. Attention to agency and accountability was identified as priority areas for future research and outreach.

This debate was taken one step further at the 2019 Munich Organisations and Society in Information Systems (OASIS) workshop on post-digitalization (Parmiggiani et al. forthcoming). Group members were invited to consider what will happen once the temporary excitement about digitalization ceases and phenomena currently discussed as digital (e.g. digital innovation, digital transformation, digital business strategy) have become inherently and so naturally digital that they are not discussed separately anymore. While it was evident that there are many different and often conflicting interpretations of post-digitalization, anticipating a future where things being digital is the norm will be crucial to imagine and shape the trajectory of organisations and societies as digitalization becomes ever more pervasive. This is particularly true if research is to help pave the way for a just and inclusive digital future that promotes new forms of organising and novel ways of working, which contribute positively to addressing contemporary economic, societal, and environmental challenges.

Looking forward, we would draw a number of lessons from WG8.2's history and ethos for the future of TC8. First, while the tidal wave of data about organisational and social phenomena that digitalization has unleashed has been viewed in some quarters as meaning that all IS phenomena can, and should, be studied exclusively with quantitative methods, such a loss of methodological diversity in the field should be of concern on a number of grounds. It assumes, for example, that data unproblematically instrument reality—something that qualitative research on practices of data creation can help to interrogate. It treats data as the sufficient cause of phenomena without reference to social and organisational processes that are not well suited to quantification, and it

assumes a stability and directionality to the relationship between data and phenomena that is thrown into doubt by the ongoing reconfiguration of organisations, society, and perhaps even humans themselves (Czerski 2012, Introna 2009). Continuing methodological innovation will be needed to enable academia to keep pace with these developments and to address the complexity of emerging phenomena.

Second, and in tandem with methodological advances, there will be a need for new conceptualizations of theory that are responsive to the potential as well as the contingencies of digitalization. Despite predictions of the end of theory—be it because of the ad-hoc analytical capabilities that result from the combination of artificial intelligence with big data or because of the perceived deficiencies of existing conceptualizations and their effects on the discipline (e.g., Avison and Malaurent 2014, Hirschheim 2019)—the WG8.2 tradition provides evidence of its persistent relevance.

Third, genuine inter-disciplinarity (or rather multi-disciplinarity) is needed to enable us to grasp the manifold impacts of digitalization. Comprehending technology not only as an object of engineering skill—obsessed by the technologically possible—but also as a societal, legal, environmental, ethical, and philosophical challenge is necessary to gain rich insight on, explain, and shape the interaction of information systems and organisations (broadly speaking).

WG8.3: Decision Support

The International Federation for Information Processing (IFIP) was founded as a federation of national peak bodies in information processing and technology under the auspices of UNESCO. IFIP established Technical Committee (TC) 8 Information Systems in 1974 in recognition of the maturing nature of Management Information Systems (MIS) as a field of research and practice. The 1970s also saw the establishment of decision support systems as a newly mature area of information systems research, as evidenced by the publication of Gorry and Scott Morton's seminal work in 1971. Consequently, in 1981, IFIP TC8 established WG8.3 on Decision Support Systems (DSS).

The stated aim of IFIP WG8.3 was 'The development of approaches for applying information systems technology to increase the effectiveness of decision-makers in situations where the computer system can support and enhance human judgments in the performance of tasks that have elements which cannot be specified in advance'. The means it proposed to use were 'To improve ways of synthesising and applying relevant work from resource disciplines to practical implementations of systems that enhance decision support capability'. Resource disciplines included information technology, artificial intelligence, cognitive psychology, decision theory, organisational theories, operations research and modelling.

Since its creation, WG8.3 has organised a total of twenty-three international conferences over its thirty-nine years of existence. These events have taken place in Europe, reflecting the distribution of working group members, hosted in 21 different cities and 13 different countries. London (England) and Cork (Ireland) are the only two cities to have hosted two conferences, but several countries have hosted more than one conference and the next event in 2022 promises to bring the conference back to Budapest, where discussions towards the creation of the working group were held all the way back to 1980.

The working group organised its first conference in 1982 and this took place in Austria. The beautiful 'Schloss' buildings of the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria (just south of Vienna) had been selected due to the fact that it was accessible to researchers on either side of what was then known as the 'iron curtain'. A feature of the early days of the working group was to enable the interaction between academics working on different sides of this particular political divide. A bi-annual pattern of conferences was established, each conference planning the theme and location of the next event. The last international conference of the working group was due to be held in 2020 in Wroclaw (Poland) but global events that year and the spread of the COVID-19 virus brought travel restrictions which meant that the conference was in fact held on an on-line platform (quite successfully so, actually). In between 1982 and 2020, 20 bi-annual conferences were held. In addition, there were 3 major conferences outside of the established bi-annual pattern, in 1991, 1993, and 1997 when group members decided to meet on an annual basis. In total, over 750 papers have been published in these 23 events. Over the years, special issues of journals were also published, most of which contain extended versions of the papers published in the official proceedings.

Other outputs of the working group have been identified in the annual reports of the group. For instance, the working group published its own work on the "DSS curriculum" at its conference in Toulouse in 2008 reporting on the work of its 'DSS Curriculum' task force, established two years earlier at the 2006 conference in London.

Over the 23 conferences, 750 papers have been published by nearly a thousand individual authors who represented over 380 institutions from over 50 countries. This is a remarkable accumulated body of knowledge and constitutes a substantial contribution to the discipline of DSS over a very long period and across a variety of sub-topic of the discipline.

Thus, contributing authors come from a wide range of institutions representing many countries. The growth in the geography of contributions is a commendable reflection of the concerted efforts invested by successive officers of the working group to invite new researchers from increasingly diverse horizons into the group, especially since 2002 where the conferences became noticeably larger. Arguably, this might also be explained, at least in part, by the increasing ease with which academics can communicate with each other resulting from the growth in use of the Internet. The significant jump in numbers of papers, authors and institutions is evident in 2002 and 2004. Prior to this time, the conference was comparatively small, with most conferences including less than 40 authors and 20 presented papers, dominated by European authors.

From 2002, a broader range of participants and a higher number of papers were included in the conferences. Analysis of the publication patterns shows three different epochs in the conference history: 1982–2000 with small conferences dominated by European and, to a lesser extent, authors from the United States; 2002–2006 large scale conferences with a larger cross-section of authors from Europe, the USA, Australasia and Asia; and 2008 onwards, with medium scale conferences, and a spread of authors from various regions, albeit dominated by European and Australasian participants. Overall, the working group is now a more diverse, more collaborative community.

Historically, each conference of the working group has had a dedicated theme. These themes have been identified at the successive business meetings of the working group, often proposed by the would-be host of the next conference and accepted by present group members. As is evident in the table below, the themes proposed by successive hosts have alternated between following broad trends within the IS field, towards novel concepts and ideas (e.g. DSS 2.0 – Paris, 2014), and trying to refocus the efforts of the working group on the important core topics of the DSS field (Decision Support Systems: A Decade in Perspective – Noordwijkerhout, 1986). However, irrespective of the stated conference themes, there has been a wide range of recurring topics discussed over the years, some of them thoroughly researched over the entire lifecycle of the working group. These topics represent practical problem areas on the one hand (i.e. what field or activity the problems being supported come from) and decision support aspects (i.e. whether the main question relates to technical or general decision-making issues).

The interest in supported domains and DSS areas has changed considerably over time - yet, at the same time, the group remained focused on support issues related to decision-making. The dichotomy between the focus on decision-making issues on the one hand and technical issues on the other hand is arguably exactly as it should be in a field of inquiry such as DSS, as it reveals a well-balanced dual focus on both the domain of application and the underlying tools and techniques / technology. It is very interesting however to see that the balance between these two focal points has shifted from conference to conference and the equilibrium has been achieved over the complete lifecycle of the working group rather than within each of the conferences.

Generally, in early conferences, working group authors investigated general aspects of decision support, considering both relevant questions of decision-making and issues related to the development aspects of DSS. In later conferences, technical issues became less relevant (with the exception of 2000, where the emergence of Internet-based solutions dominated the conference). On the other hand, general decision-making aspects remained strong over the entire period.

In conclusion, while the most important topics of the conference were about general decision-making and decision support issues, there was a good range of real-life professional and industrial questions covered as well. WG8.3 has made its mark globally in these areas as listed in the table below:

1982 Processes and Tools for Decision Support
1984 Knowledge Representation for Decision Support Systems
1986 Decision Support Systems: A Decade in Perspective
1988 Organisational Decision Support Systems
1990 Environments for Supporting Decision Processes
1991 Support Functionality in the Office Environment
1992 Decision Support Systems: Experiences and Expectations
1993 Decision Support in Public Administration
1994 Decision Support in Organisational Transformation
1996 Implementing Systems for Supporting Management Decisions
1997 Decision Support in Organisational Transformation (reinvestigation based on the 1994 event)
1998 Context Sensitive Decision Support Systems

2000 Decision Support through Knowledge Management
2002 Decision Making and Decision Support in the Internet Age
2004 Decision Support in an Uncertain World
2006 Creativity and Innovation in Decision Making and Decision Support
2008 Collaborative Decision Making: Perspectives and Challenges
2010 Bridging the Socio-technical Gap in Decision Support Systems - Challenges for the Next Decade
2012 Fusing DSS into the Fabric of the Context
2014 DSS 2.0 – Supporting Decision Making with New Technologies
2016 Big Data, Better Decisions, Brighter Future
2018 DSS Research Delivering High Impacts to Business and Society
2020 Toward Enhanced Risk Management, shaping Risk Culture Theory and making Sound Decisions under Pressure

WG8.4: E-Business: Multi-disciplinary Research and Practice
WG8.4 was established in 2001. WG8.4 provides a reference point and a focus for multi-disciplinary research and practice in E-Business Information Systems. The intention is to extend the IFIP community's focus on E-Business to recognise, acknowledge and facilitate research and practice as it crosses the boundaries of IS, organisational, consumer, community, industry and national domains. Where researchers and practitioners focus on specific issues and technologies, for example, smart-card developments, mobile technologies or organisational adoption of IT practices, then that research is more properly located within existing working groups.

In 2017 the International IFIP Cross Domain (CD[1]) Conference for Machine Learning & Knowledge Extraction (MAKE[2]) - CD-MAKE 2020 has been founded as a joint effort of IFIP TC5, IFIP TC12, IFIP WG8.4, IFIP WG8.9 and IFIP WG12.9. CD-MAKE is held annually in conjunction with the International Conference on Availability, Reliability and Security ARES.

The conference is dedicated to offer an international platform for novel ideas and a fresh look on the methodologies to put crazy ideas into business for the benefit of the human. Serendipity is a desired effect and is expected to cross-fertilize methodologies and transfer of algorithmic developments.

Machine learning deals with understanding intelligence for the design and development of algorithms that can learn from data and improve over time. The original definition was "the artificial generation of knowledge from experience". The challenge is to discover relevant structural patterns and/or temporal patterns ("knowledge") in such data, which are often hidden and not accessible to a human. Today, machine learning is the fastest growing technical field, having many application domains, e.g. health, Industry 4.0, recommender systems, speech recognition, autonomous driving, etc. The challenge is in decision making under uncertainty, and probabilistic inference enormously

[1] CD stands for Cross-Domain and means the integration and appraisal of different fields and application domains (e.g. health AI, Industry 4.0, etc.) to provide an atmosphere to foster different perspectives and opinions.
[2] MAKE stands for MAchine Learning & Knowledge Extraction.

influenced artificial intelligence and statistical learning. The inverse probability allows to infer unknowns, learn from data and make predictions to support decision making. Whether in social networks, recommender systems, health or Industry 4.0 applications, the increasingly complex data sets require efficient, useful and useable solutions for knowledge discovery and knowledge extraction.

A synergistic combination of methodologies and approaches of two domains offer ideal conditions towards unraveling these challenges and to foster new, efficient and user-friendly machine learning algorithms and knowledge extraction tools: Human-Computer Interaction (HCI) and Knowledge Discovery/Data Mining (KDD), aiming at augmenting human intelligence with computational intelligence and vice versa toward a human-centered AI approach.

Consequently, successful Machine Learning & Knowledge extraction needs a concerted international effort without boundaries, supporting collaborative and integrative cross-disciplinary research between experts from 7 (the magical number seven $\pm$ 0) fields:

1. DATA – Data science (data fusion, preprocessing, mapping, knowledge representation, …),
2. LEARNING – algorithms, contextual adaptation, causal reasoning, transfer learning …
3. VISUALISATION – intelligent interfaces, human-AI interaction, dialogue systems, …
4. PRIVACY – data protection, safety, security, ethics, acceptance and social issues of ML, …
5. NETWORK – graphical models, graph-based ML, Bayesian inference, …
6. TOPOLOGY – geometrical machine learning, topological and manifold learning, …
7. ENTROPY – time and machine learning, entropy-based learning, …

The goal of the CD-MAKE conference is to act as a Catalysator to bring together researchers from these seven areas in a cross-disciplinary manner, to stimulate fresh ideas and to encourage multi-disciplinary problem solving. Since 2017 the conference has taken place in Reggio Calabria, Italy (2017); Hamburg, Germany (2018); Canterbury, UK (2019) and will take place 2020 as a virtual conference. We are happy to announce that CD-MAKE 2021 will take place in Dublin, Ireland.

More information can be found here:
https://ifip84.sba-research.org/index.html
https://cd-make.net/

WG8.5: Information Systems in Public Administration

WG8.5 was approved by TC8 in 1988, and this WG is focused on all aspects of information systems for governments. WG8.5 covers electronic service provisioning, government operations, citizens engagement, democracy, social innovation, and other forms of electronic participation. In the early years, the focus of the working group was on the automation of single systems within a single public organisation. Over time, the emphasis has shifted, and the interoperability between public organisations became a prime

focus as more and more public organisations started to collaborate using information systems. Due to all kinds of technological advancements, the scope has been expanded considerably by focusing nowadays on a complete digitalization and transformation of the public sector for public value creation.

Around the year 2000, the name e-government, and more recently the name digital government, was introduced to refer to this domain. This has resulted in the establishment of the annual International e-Government Conference, abbreviated at EGOV, in 2002 by scholars like Roland Traunmüller and Klaus Lenk. Over the subsequent years, IFIP WG8.5 has played a significant role in the automation of government administrative processes, the development of integrated service provisioning, and online forms of participation. This research has resulted in insight for integrated service provisioning, including components for accomplishing this like the only once principle, interoperability frameworks and methods, and citizens and companies are now able to browse to a single website for gaining services from different government organisations without being aware of this.

Over time, more and more emphasis was given to democracy, participation, and engagement using digital means. These developments resulted in 2009 in the first International e-Participation conference, abbreviates as ePart. EGOV and ePart papers are published in the renowned Springer LNCS proceedings, and both conferences are always co-located. In 2018, another conference was merged with EGOV and ePart, e.g., the Conference for E-Democracy and Open Government Conference (CeDEM) expressing the rise of e-democracy. This has resulted in the joint conference on EGOV, which attracts the major researchers in this area. IFIP WG8.5 has developed into a vibrant community with many active members and having as the main highlight the annual EGOV conference.

Over the years, new topics emerged and were embraced like open data, open government, public-private governance and smart government. The IFIP WG8.5 community contributed to the development of effective policies and systems for the opening and use of more data and contributed to accomplishing open government for public sector organisations all over the world. Also, the community contributed to understanding the smart government phenomenon and showing how information systems can be used for the creation of public values.

More recently, numerous subtopics have been introduced into this thriving field, including social innovation (improving the society driven by parties outside the government), transformative government, sustainable government, legal informatics, and algorithmic public decision-making. All are referring to different aspects of ICT in public administration. The many and various topics show the need for understanding the type of information systems within the government context. In-depth knowledge of the public administration field and type of information system is needed to analyse, understand, and design information systems in public administration.

The uniqueness of the WG8.5 is that it concentrates on a specific area of society, namely the public sector. As a domain discipline, insights and areas from other fields are used; however, the very nature prevents the easy translation of theories, methods, and principles. The idiosyncratic nature of governments requires the development of specific theories, methods, and principles. For example, legislation and the translation of legal

requirements and rules in information systems is an important aspect in this domain. Therefore, also research in policy-making for the digital world is conducted by this working group. Furthermore, the focus of the public sector is on creating public values and serving the public. Whereas the objectives of for profit-companies are to satisfy their customers, in government all too often, societal trade-offs are needed, and inclusion is an important topic. Information systems should meet public values like accountability, transparency, equal access, fairness, openness, privacy, and so on. Also, the various roles that people can have in our society should be considered. A single person can be a voter, a citizen requesting public services, a data analyst making use of open government data, or even all at the same time.

Public value creation using information systems is a core focus area of the WG8.5. Government structures are shaped by principles founded in legislation like separation of concerns and contain mechanisms for ensuring public accountability and oversight. Information systems and institutional aspects are interlinked in this domain. Furthermore, governments are organised differently per country, which poses limitations to the generalizability. This all requires a deep understanding of the public sector and knowledge about information systems. More and more researchers have entered this very relevant field, but combining these areas remain challenging.

The public sector increasingly relies on Internet of Things (IoT), Artificial Intelligence (AI), (Big) Data Analytics (BDA), Blockchain, 5G, and related technologies to improve and transform the government. WG8.5's methodological and theoretical advances provide an important foundation for addressing emerging topics like sustainable cities in which the government encourages the sustainable use of resources using all kinds of information systems. This is often in close collaboration with companies. Also, the theories for automation and transformation can be used for the domain of computational algorithms for automated decision-making. Automating decisions can have far-reaching consequences to people's lives, harvesting interconnected data about individuals, and has the risk that exclusion, injustice, and privacy violations can happen on a massive scale. The methods and theories developed by WG8.5 ensure adherent to public values, like fairness and openness, are taken into account. The public values perspective is closely related to the ethical implications of the use of new technologies.

The public sector and the public are highly dependent on each other. The research in co-creation and engagement plays an important role in innovating the public sector, improving public service delivery, and providing opportunities for public participation. Society becomes more and more involved in improving the government. Social media is becoming an increasingly important interface between the public sector and the public. In conclusion, digitalization and the government have become integrated over the years. Government phenomena have become inherently digital, and they should not be considered in isolation anymore.

We can draw several lessons from WG8.5's advancement for the future of TC8. Information systems and the public sector should be approached as an integrated whole and should be viewed as a socio-technical phenomenon. Information systems are shaped by their context but also influence the context. Aspect like legislation, institutional structure, and public values should be taken into account when analysing and designing information systems. This results in a multitude of aspects like inclusion, fairness, openness,

accountability, privacy, and transparency that play a vital role in making these information systems a success. Many of these aspects sound easy, and most people will agree with the need for adhering to them, but these are hard to put into practice. Hence, dedicated theories and methods are needed which take the nature of the domain into account and are able to help a domain forward. Reductionist approaches are necessary for general insights, but understanding an empirical domain, like the public sector, is needed for ensuring a practical relevance and the ability to relate theory and practice. This requires specific socio-technical theories and methods which take the very nature of a domain into account.

WG8.6: Transfer and Diffusion of Information Technology

The group is focused on diffusion, transfer and implementation of IT. Established in 1994, the first official working conference was on October 1995, at Leangkollen, Oslo, Norway. It was organised by Karlheinz Kautz, Jan Pries-Heje, Tor J Larsen, and Pal Sorgaard. However, in 1993, a formation conference was held in October 10–13, at Champion, PA, in the area also referred to as Seven Springs. The event attracted over 120 academics and practitioners from around the globe. Gordon Davis welcomed the attendees and Priscilla Fowler (Program Chair) opened the event with an overview. Three presentation tracks ran throughout. The format was atypical and allowed for afternoon outdoor activity: scheduled breaks were held from 3:30–6:00 pm so participants might admire the Fall foliage, followed by dinner, and then six working sessions that were held on both evenings. This proceeding was published as: Levine, L. (Ed.). (1994). *Diffusion, Transfer, & Implementation of Information Technology*. Proceedings of the IFIP TC8 Working Conference on Diffusion, Transfer and Implementation of Information Technology. Pittsburgh, Pennsylvania, The Netherlands: North-Holland, Elsevier Science Publishers. Since then, IFIP WG8.6 kept the tradition of being open, inclusive of academics and practitioner and aiming for deep conversations in informal settings.

The first Chair of the IFIP WG8.6 was Priscilla Fowler followed by Karlheinz Kautz, Linda Levine, Deborah Bunker and Yogesh Dwivedi (current chair). The current website for the group is: http://www.ifipwg86.org/. The group mission is centred around fostering understanding and improving research and practice of diffusion, transfer, and implementation of both mature and emerging information technologies and systems in organisations, sectors, and countries. Over the years, its working conference has been held in different countries to foster collaborations and inclusion of different research teams in different universities. The group consistently included members and conference contributors from over 30 countries in Europe, Africa, Middle East, Australia, North America, India, China, Japan, Korea, New Zealand and South East Asia (for detailed analysis, see: Dwivedi et al. 2010 and Kautz et al. 2006). The group encourages diverse methodological approaches and theoretical grounding.

In recent years, the working group's original focus, on technology diffusion and adoption, has been overtaken by myriad technical developments: the social media, mobile computing, cloud computing, agile methods, and so on. The cycle of innovation has sped up, with profound impacts on the way organisations and societies engage with transfer and diffusion of ICT systems within and between organisations, in interactions with customers, and throughout society in general. In 2016, the group discussed the evolution of the field and identified and discussed emerging trends for a new agenda, one that is

faithful to the original mission of the group but adapted to today's viral IT diffusion environment. In 2017, the group held a working conference in Guimarães, Portugal on Re-Imagining Diffusion of Information Technology and Systems: Opportunities and Risks. In this conference, diffusion and adoption of emerging technologies such as digital platforms, social media, predictive analytics and e-government platforms were discussed. In 2018, the group organised its working conference in Portsmouth, UK on Smart working, living and organising. The conference aimed to broaden the theoretical base of adoption and diffusion of technology in light of new intelligent systems and technologies and the new challenges they pose to individuals, sectors and society. The debates and discussions on the conference examined how emerging technologies are adopted and appropriated in everyday life and work, and the impact they are exerting. In particular, who is becoming smart, how they are becoming smart and what are they becoming smart about? Who are the "winners and losers" and what role does technology play? How are emerging technologies adopted and appropriated in everyday life and what impact are they exerting? The proceedings were published in Elbanna et al. (2018) and the special issue on Information Systems Frontier was also published based on selected papers from IFIP WG8.6 that were rigorously and competitively reviewed (Elbanna et al. 2020).

The group maintains its focus on theoretical and practical understanding of the adoption of a broad spectrum of information technologies. It continues to update its knowledge base in light of emerging technologies such as AI, predictive analytics, social media, cloud computing, and other emerging technologies. The focus of future events will be on understanding the diffusion and adoption of emerging information technologies and systems (i.e., Artificial Intelligence, Blockchain, Fintech Applications, Internet of Things, Social Media), which are expected to have substantial impact on future social and economic development of society, organisations and individuals. In addition, the group emphasises the importance of inter-disciplinary and multidisciplinary research. Future events will focus on fostering relationships and theoretical and practical links with other disciplines and opportunities for IS researchers to engage and collaborate with other disciplines. Our future conferences will bring together scholars and practitioners from other disciplines for the enrichment of scholarly deliberations on the ICT adoption, usage, impact and potential of emerging technologies.

WG8.9: Enterprise Information Systems

Enterprise Information Systems (EIS) also called Enterprise Systems (ES) or Enterprise Resource Planning (ERP). In the past decades, EIS has emerged as a promising tool used for integrating and extending business processes across the boundaries of business functions at both intra- and inter-organisational levels. This emergence of EIS has been fueled by the global economy and the development in Information and Communications Technology (ICT). The development of ICT and the technological advances in EIS have provided a viable solution to the growing needs of information integration in both manufacturing and service industries, as evidenced by the fact that a growing number of enterprises world-wide have adopted EIS such as Enterprise Resource Planning (ERP), to run their businesses instead of using functional information systems that were previously used for partial functional integration within many industrial organisations.

We have witnessed that, in global economy and in global business operations, there has been a need for EIS such as ERP to integrate extended enterprises in a supply chain environment with the objective of achieving efficiency, competency, and competitiveness. For example, the global operations have forced enterprises such as Dell and Microsoft to adopt ERP in order to take the advantage of a global supply network. Today, not only the large and medium sized companies, but also small companies are quickly learning that a highly integrated EIS is a requirement for the global operation. For instance, business-to-business (B2B) integration generally comprises connections to EIS. EIS has become a basic information processing requirement for many industries. Thus, the ERP market is one of the fastest growing and most profitable areas in the software industry.

It is well recognised that EIS has an important long-term strategic impact on global industrial development. Due to the importance of this subject, there has been a growing demand for research about EIS to provide insights into the issues, challenges, and solutions related to the design, implementation, and management of EIS. In June 2005, at a meeting of the International Federation for Information Processing (IFIP) Technical Committee for Information Systems (TC8) held at Guimarães, Portugal, the committee members intensively discussed the important role played by EIS in the global economy and the innovative and unique characteristics of EIS within the framework of Industrial Information Integration, an emerging scientific sub-discipline. It was decided at this meeting that the IFIP First International Conference on Research and Practical Issues of Enterprise Information Systems (CONFENIS 2006) would be held in 2006 in Vienna, Austria. In August 2006, at the IFIP 2006 World Computer Congress held in Santiago, Chile, the IFIP TC8 WG8.9 Enterprise Information Systems was established. To further respond to the needs of both academicians and practitioners for communicating and publishing their research outcomes on EIS, the science and engineering journal entitled *Enterprise Information Systems,* exclusively devoting to the topic of EIS, was launched in 2007.

Enterprise Information Systems research has become increasingly popular. In EIS research, topics of interest include enterprise engineering, enterprise modelling, enterprise integration, business process management, enterprise architecture and enterprise application integration, information integration and interoperability, service oriented architecture (SOA), etc. Techniques developed in mathematical science, computer science, manufacturing engineering, systems science and engineering, operations management used in the design or operation of enterprise information systems are included.

There are still many challenges and issues that need to be resolved in order for EIS to become more applicable. Designing EIS involves complexity which mainly stems from their high dimensionality and complexity. In recent years, there have been significant developments in this newly emerging technology, as well as actual and potential applications to various industrial sectors. Despite advancements in the field of EIS, both in academia and industry, significant challenges still remain. They need to be dealt with in order to fully realise the potential of EIS. For example, what does Industry 4.0 mean for existing EIS? According to GTAI (2014), Industry 4.0 has sparked a discussion on whether ERP, EIS or ES will establish themselves as the dominant software systems in

Industry 4.0. Although GTAI study (2014) has not given a clear-cut answer on this, it is recognised that as interdisciplinary integration is the essence of Industry 4.0, ERP, EIS or ES will have to address new challenges from Industry 4.0. According to a related study published in 2014, the authors have indicated that IoT and Cyber Physical System (CPS) related technologies have made a large impact on new ICT and future ERP, EIS or ES. In this study, it was predicted that new generation of ERP, EIS or ES will emerge from new ICT with the capacity of CPS (Xu et al. 2014). EIS will continue to embrace cutting-edge technology and techniques and will open up new applications that will impact industrial sectors.

WG8.10: Service Oriented Systems (Joint with WG6.12 and WG2.14)
The role of WG8.10 is organising and promoting a fruitful exchange of information among academics and practitioners within the scope of improving the engineering, further research, and exploitation of service-based systems.

The research community has been considering Service Oriented Computing a relevant topic to be studied for some twenty years. Although most of the initial ideas and proposals are now widely adopted in industry, the evolution of the underlying platforms has required a continuous improvement of the already proposed approaches as well as the definition of new methods and tools. For instance, we started from systems integration based on RPC-like protocols (e.g., SOAP) and architectural styles that allow us to provide better flexibility and scalability (e.g., REST). In the meanwhile, service orientation evolved: it is not only a way to remotely invoke software components using Internet as communication backbone, but it is also the basis of cloud computing where infrastructures, platforms, and services are offered "as a service".

The IFIP WG on Service Oriented Systems, established in 2010, has brought together researchers and practitioners to study the potential of service oriented computing along several directions including, among others, service modeling, service platforms, and methodologies to manage the service life-cycle. Over the last few years, the contribution of the WG members has focused on the latest development of service oriented computing. Most of the contributions of the members have been included in the proceedings of the European Conference on Service-Oriented and Cloud Computing (ESOCC), the flagship conference of the WG. For example, in the recent period, a lot of attention has been devoted to microservice-based architectures and edge/fog computing.

About the former, microservices are gaining more and more momentum in enterprise IT, with IT leading companies (such as Amazon, Netflix and Spotify) already delivering their core businesses through microservice-based solutions. Microservices define an architectural style for developing applications as suites of small and independent (micro)services, each of which is built around a well-defined business capability, running in its own process, and communicating with the other microservices in an application through lightweight mechanisms. Architecting an application with microservices can result in various gains, related to peculiar properties of microservices themselves. These gains include the natural exploitability of patterns while designing an application, the freedom of choosing the technologies and databases for implementing each microservice and its backend, and the native support for fault resilience and CI/CD (Continuous Integration/Continuous Delivery), just to mention some.

At the same time, application developers and operators have to face various open challenges on microservices. For instance, sizing services to match business capability is not easy, as the border among different business capabilities is often blurry. The biggest challenges however come from the highly-distributed nature of microservices, which makes securing an application and controlling accesses a concrete pain. The same applies to testing, especially if wishing to check the overall performance of an application. For the same reasons, monitoring the runtime operation of a microservice-based application is quite complex, as monitoring/logging data is distributed over the various microservices forming an application and needs to be suitably combined. We hence believe that securing, testing and monitoring highly distributed microservice-based applications constitute three concrete challenges for next years' research on service-oriented systems, especially if considered in combination with emerging fog/edge infrastructures (which are distributed, geolocated and mobile, and which feature stringent QoS requirements).

Moving to the edge/fog computing, the impact of the network in the service provisioning/consuming might be relevant especially when a significant amount of data is considered. The typical scenario refers to Industry 4.0 where manufacturing plants are planned to be extensively sensorised, thus able to generate a huge amount of data about the status of machineries, as well as the status of the processes being enacted. To mine useful information from this data, the current approach is to move these data to the cloud where (theoretically) unlimited resources are available to process these data and to return back to the user the results of this analysis. As said, the network could be so impactful that the network latency could return the result of the data with an unacceptable delay. For this reason, fog computing has been proposed to exploit as much as possible the resources at the edge of the network thus to process the data as close as possible to where they are produced. In this way, the amount of data that will be moved to the cloud is reduced. In such a scenario, several challenges must be addressed: how to select which data to process at the edge and which on the cloud; how to ensure the privacy of the data, i.e., the data that cannot leave the premises where they are generated; how to deal with an extremely heterogeneous environment where sensors, smart devices, network devices, as well as cloud resources are involved: and finally, how to manage the dynamicity of a system in which nodes could join and leave the infrastructure without prior notice.

As said, these are just two of the main domains in which the WG community is currently working. For sure, the service orientation will change its skin again in the near future, as the concept of service is so pervasive that needs to be adapted to very different scenarios, and the goal of the WG is to grab the chance to find out new methods and tools to support new cases.

WG8.11: Information Systems Security Research (Joint with WG11.13)

The working group on Information Systems Security Research WG8.11 is a joint working group focused on the creation, dissemination, and preservation of well-formed research about information systems security. Listed under both the International Federation for Information Processing (IFIP) Technical Committee TC8 (Information Systems) (WG8.11) and IFIP TC11 (Security and Privacy Protection) (WG11.13), this working group places a premium on research with highly reliable and validated theory, empirical data, or quantitative/qualitative social scientific methodology. Since its formation in 2008, the working group has focused largely on research on the social, organisational,

and managerial challenges pertaining to information security management, including both workplace and home information security. More recently, however, the challenges of interest have mostly centered on behavioral compliance and risk management issues.

Behavioral compliance research is generally focused on the adoption and use of protective security practices by individuals either seeking to benefit themselves or their firms or avoiding negative consequences that result from the non-adoption or misuse of security procedures and methods. Our membership is placed an emphasis on policy related compliance, but other forms of compliance, such as with digital warnings, communicated alerts, and compliance with emerging technical standards have also been examined. A recent working group workshop suggests the behavioral compliance area of study will remain a focus of study for the foreseeable future.

Risk management is the other primary research interest among our membership. The study of risk management by security researchers has mostly been conducted from a normative perspective (Hui et al. 2016) and while our membership has addressed risk management through a variety of frameworks, models, and management techniques, its focus has mostly been on efforts to extend and contextualise the managerial frameworks and theories that help to measure and control risk at the individual level.

Going forward, the IFIP TC8.11/11.13 working group looks to emerging challenges such as neurosecurity (neurophysiological data collection), forensics analysis, and the behavioral analysis of design science treatments that enhance or balance security and privacy tradeoffs. The growing prevalence of advanced persistent threats, blockchain data structures, big data analytics, commercial cyberspace collisions between defensive AI and offensive AI, and quantum computing has presented a new set of organisational and managerial challenges that we are eager to tackle.

WG8.12: Industrial Information Integration

In the first part of the first decade of 2000, the impact of ICT (Information and Communication Technology) on industry has been going beyond the traditional paradigm. It affects industrial processes and production in an unprecedented way. It became more and more clear the emergence of Industrial Integration grew out from a new era of ICT. Due to the strategic importance of the subject, there has been a growing demand for research on Industrial Information Integration to provide insights on issues, challenges, and solutions related to industrial integration.

In 2007, at a European Seminar held in Zurich, a session was dedicated to "Industrial Integration of ICT" aimed at exploring the industrial integration of ICT in manufacturing sector (Abramovici and Filos 2011). In 2008, Fujitsu of Japan challenged the industrialization of IT based on three core technologies: virtualization, automation, and integration (Sagawa and Mitsuhama 2008). Kopar (2008) indicated that information integration become a real challenge, even in NATO. Hua et al. (2008) and Liang et al. (2008) studied the key role played by information integration in industrial information integration and Zajac et al. (2008) studied information integration in manufacturing systems.

Industrial Information Integration encompasses not only information integration, but also hardware and software. Estevez and Marcos (2008) emphasised the integration of tools in engineering process. In 2010, Zuge et al. emphasised the significance of integration of IT with automation technology in information integration. In the same year, Huang (2020) indicated the important role of integration in industrialization and

informatization. In 2011, Abramovici and Filos (2011) indicated that emerging ICTs are expected to drive innovations in information processes across the product lifecycle as well as new industrial business models. In 2012, Marinica describes a real case of methodologies and hardware and software systems used to build the road from electrical signal to information. Castillo and Rosario (2012) proposes a generic supervisory and command architecture in which technology and industrial devices have been integrated in a single platform. Such devices include programmable logic controllers, sensors, actuators, image processing, supervisory systems, and robotic manipulation devices. Li et al. (2012) discuss equipment integration for agricultural applications. Narayanan and Haralur (2012) propose seamless integration of network devices.

In 2015, Yue et al. indicated that the development of industrialization and ICT has deeply changed our way of life; in particular, with the emerging Industry 4.0, the integration of cloud technologies and industrial cyber-physical systems (ICPS) becomes increasingly important. Also in 2015, Ministry of Industry and Information Technology of China launched the China Manufacturing 2025 Plan. This 10-year action plan calls for increasing integration of industrialization and information technology. Nine tasks have been identified as priorities, one of them is integrating Information Technology and Industry.

Due to such industrial practice paradigm shift, the new subjects Industrial Integration and Industrial Information Integration have risen, directly resulting in the formal proposal on Industrial Information Integration to IFIP. In June 2019, IFIP TC8 WG8.12, was established, specifically focusing on the Industrial Information Integration. This is the first working group established in IFIP on Industrial Information Integration. In 2016, the journal entitled *Journal of Industrial Information Integration* was launched.

Industrial Information Integration Engineering (IIIE) is a set of foundation concepts, techniques, and technology that facilitate the industrial information integration process; specifically speaking, IIIE comprises methods/techniques for solving complex problems in developing information technology infrastructure for industrial sectors, especially in the aspect of information integration. As an interdisciplinary discipline, IIIE interacts with scientific disciplines such as mathematics, computer science, and engineering disciplines.

In recent years, rapid advances in industrial information integration have spurred tremendous growth in the use of integrated industrial systems (Chen 2016; 2020), so far a variety of techniques have been used for probing IIIE. These techniques include business process management, workflow management, EA/EAI, SOA, IoT, among others. Many applications require a combination of these techniques; this also gives rise to the emergence of IIIE that requires techniques originated from different disciplines. At present, we are at a new breakpoint in the evolution of selected enabling technologies for IIIE.

5 Conclusions

So how do we proceed into the next 50 years? The world at present and the world of the 1970s when TC8 was formed are very different. In economically advanced societies, we are passing beyond the Information Society (Society 4.0) with its information ‘pull’

mechanisms towards Society 5.0, the essence of which promises to be more cautious and caring locally and more aware globally. Most importantly, we are becoming attuned to the imperative to consider the fragile health of both society and earth, aided by the ready availability of AI-enabled converged information and other emerging technologies.

At the end of Sect. 3, the question was asked "Based on this impressive history, a natural question to ask is how TC8 can inform a strategy for the future?" The answer was given that we should stick to what TC8 has been good at (design and development, application and utilisation in organisations) but not be neglectful of the growing societal and environmental focus on Smart Cities and Green Sustainability. Should these topics and others requiring socio-technical responses in Society 5.0 be picked up by an existing working group or addressed by a new working group? Whatever the answer, TC8 will be found at the forefront of information systems thought leadership in the post-COVID world.

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