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Is anyone listening? Evaluating the impact of decision systems and analytics research

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ABSTRACT

The decision support systems (DSS) area is an integral part of the Information Systems discipline. DSS's main objective is to contribute to the common good by facilitating access to relevant information for improved decision-making. IFIP Working Group 8.3 Decision Support was established in 1981 as a community passionate about creating a body of knowledge on how to support better decision-making. The advances in addressing this mission were regularly presented at the bi-annual meetings of the IFIP WG8.3. Our aim in this paper is to analyse the impact of the research of the group through these conference proceedings. We use a 'test of time' as a starting point to identify the sample of papers that have been most noted and cited. Further analysis helps to clarify other parameters that define the impact of this research and allow us to propose strategies to inform more impactful research outcomes in the future.

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impact; citation analysis;
evaluation criteria;
test of time

1. Introduction

Academic researchers have often been urged to shift their focus to more impactful research for public good (Hoffman, 2021). The definitions of impact may differ depending on discipline, but as a minimum, the number of citations in Google Scholar is treated as one indicator of the research publication's impact to provide evidence of scientific contribution. In the area of Decision Support Systems (DSS) the issue of impact has not been agreed upon, but it has not been a question for community debate either. In this work, we aim to rise to this challenge by looking at the tangible output produced by the members of our community and propose how we can define the impact that our research has made over time using the parameters of a Test of Time competition as a mechanism for interrogating this effort.

The IFIP working group 8.3 (IFIP WG8.3 Decision Support) was established in 1981 and held its first open conference in 1982 and every second year since then (Csáki et al., 2016;

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IFIP, 2023). The objective of establishing the group was to bring together a community of scholars and professionals passionate about creating a body of knowledge to address complex analytics to support decisions with or without technology. The papers presented at the bi-annual meetings of the IFIP WG8.3 demonstrated the authors' efforts to advance the theoretical basis for improved decision support, as well as applications of such advances in solving individual, organisational, and societal challenges for common good. Each meeting published a collection of refereed papers available for public dissemination to learn about the state of the art in decision-making support theory and practice at the time. The broad themes addressed by the conferences organised by this group is an illustration of such an agenda which is only driven by the desire to study the whole range of issues which contribute to supporting better decisions for the common good of individuals, organisations and society more broadly.

While each conference was deemed to be a good example of a worthy academic endeavour and guided by a topical theme and the papers were selected to represent the best efforts to address these topics, the overall impact of this research community is difficult to estimate. Thus, it is timely to interrogate the impact that this research community has made over time and define some strategies to ensure that future efforts are more transparent in guiding the IFIP WG8.3 group towards more impactful and influential research outcomes. In this paper, we analyse the impact the group made through papers from the conference proceedings. We used the 'Test of Time' (ToT) criteria as a starting point to identify the sample of papers which were most noted and cited overall, and in the past few years in particular. We made the initial selection of such papers and developed a set of criteria beyond just the number of citations attracted by candidate papers, adapting them from the ToT criteria analysis used by other research communities. We invite the conference participants to further review the proposed definition of the impact and confirm the selected candidates from the past conference publication proceedings.

The paper is structured as follows. First, we provide a background of the various factors which define impactful research in the disciplines that offer the ToT awards. We analysed the total set of these evaluation criteria and classified them into clusters to determine their relevance for our research area and IFIP WG8.3 conference publications in particular. We then illustrate how these criteria could be useful to assess the ToT impact of the conference publications for the past 23 years. The research method for this literature analysis is described. The results are presented including a definition of the proposed set of criteria as illustrated by the papers to which these criteria apply. We propose some points of discussion and a future research considerations and strategies which should be useful in guiding the research efforts of early career researchers and doctoral students in particular.

2. Defining a test of time impact in the discipline of decision support

The Test-of-Time Award is a common approach to recognise outstanding papers published in a period of time in a specific discipline or research area. It is defined differently by diverse communities (for example IEEE and ACM). In those disciplines, the Test-of-Time award is typically selected by an Award Committee appointed by and selected from the community. Despite its long-standing and sustainable status, IFIP WG8.3 group has not established such an award yet. Instead, there were attempts in the past to record and

review contributions the IFIP WG8.3 community made through the conference proceedings. For example, Csáki et al. (2016) presented a comprehensive analysis of individual contributions. In this effort, our aim was to look instead for research papers that have had a sustained and important impact on the theory and/or practice of DS research.

2.1. Criteria of test of time impact

Test of time (ToT) awards are given by research organisations to recognise individual contributions, provide role models to encourage their community's directions, and to assess the impact of their research outputs. The award is generally understood as recognition by other experts over a long period of time. Since research fields gain traction within a community as interests ebb and flow, the interpretation of a 'long time' varies. Papers published at one time may not be deemed relevant until years later, while other papers may be widely acknowledged briefly but then fall out of use. Thus, a description of 'test of time' is elusive.

In addition, IS is a relatively new field of study since computers came into use in the mid-1900s and initially were available only to a small group of expert users. The advancement of technologies such as the Internet in the 1960s together with lower costs of production led to the rapid spread of computers into business functions and eventually to personal use in homes. The many technology-oriented research communities can trace their formation to the explosion of interest in creating, developing, implementing and applying computing solutions to solve problems or dream up new capabilities. For example, the International Federation of Information Processing (IFIP) was established in 1960 and the Association of Information Systems (AIS) in 1994; thus, the test of time for IS topics is often calculated in increments of decades.

A sample of technology organisations and associated test of time criteria is shown in Table 1. IEEE states that its Test of Time Award is 'to encourage researchers to aim to produce work that is forward looking and has transformational potential'. (see: <https://ieeewis.org/year/2022/info/awards/test-of-time-awards>, IEEE, 2024). Many organisations rely on a small group of experts in the field to determine suitable candidates for test of time awards. Still, others provide some guidelines for a committee to consider. As illustrated in Table 1, criteria can include both objective and subjective factors.

The most stated objective factor is the number of citations in a time period, and the most usual time period is 10 years. That is, over the past 10-year window, the paper from the group or conference with the highest number of citations is usually considered as a candidate. Other objective factors are sometimes taken into account such as the way the paper is used to build new research or establish a new direction, whether the research led to an application or is used by practitioners, or the type of research such as theory or practice. Subjective measures are always part of the deciding factors since a panel of experts must apply their individual assessment. These measures include quality, influence of the ideas in the paper, scope of impact such as narrow or broad, and potential future of the ideas.

Some organisations provide justifications for papers selected for the Test of Time award, and a sample of descriptive language is shown in Table 1. Phrases used to describe these papers include probes deeper questions, methodology, rigorous, greater and deeper reflection, solved outstanding issues, long-lasting

Table 1. Sample of organizations that give test of time awards.

Organization	Criteria and selection process	Time Horizon of Award	Justifications for selection
IEEE Vis https://ieevis.org/year/2022/info/awards/test-of-time-awards	<ul style="list-style-type: none"> Objective measures such as the numbers of citations Subjective ones such as the quality and longevity and influence of ideas, outreach, uptake and effect not only in the research community, but also within application domains and visualization practice. 	<p>Vis a 10-year test of time award</p> <p>InfoVis a 10- and 20-year award</p> <p>SciVis a 14-, 15- and 25-year award.</p>	<p>Probes deeper questions</p> <p>Standardizes vocabulary.</p> <p>Accessible framings</p> <p>Citations, including recent ones.</p> <p>Widely applied.</p> <p>Rigorous, new empirical study</p> <p>Greater and deeper reflection</p> <p>Methodology</p> <p>Principled foundation</p> <p>Solved outstanding issues.</p> <p>Used by major organizations.</p> <p>Opened further developments</p>
TCRTS IEEE https://cmte.ieee.org/tcrts/wp-content/uploads/sites/180/2020/12/ToT-Award-evaluation-criteria_v8-final.pdf	<ul style="list-style-type: none"> Number of citations. The paper can be considered as a seminal work taken as a reference to build further research on the same area. Relevance for the real-time community (topic related to real-time conferences). Theoretical contribution on real-time systems research. Practical impact on the industry (demonstrated by a clear evidence) or potential impact (judged by the ToT Awards Committee). Breadth of the impact (i.e. the paper may have solved an open problem, but the area is too narrow and very few people care about that problem). 	<p>At least one decade</p> <p>Nomination</p> <p>Awarded only once.</p>	

(Continued)

Table 1. (Continued).

Organization	Criteria and selection process	Time Horizon of Award	Justifications for selection
ACM SIGCOMM https://www.sigcomm.org/awards/test-of-time-paper-award	Papers published in Computer Communication Review or any SIGCOMM sponsored or co-sponsored conference that is deemed to be an outstanding paper and whose contents are still a vibrant and useful contribution today.	10–12 years	Long-lasting impact Novel, data-driven design and implementation Setting new standards Articulates a vision for what is today a standard. Upended understanding Inspired new research. First attempt, spawning new directions. Resurgence of interest Produced a dataset used by subsequent efforts. Ushered in a new era
IFIP/IEEE DSN https://www.dependability.org/?page_id=373	Criteria should be defined according to the best practices in scholarly evaluation: holistic peer review assessing impact on several fronts, such as, but not confined to, academic, educational, technical, industrial; assisted and tuned by objective evidence deemed appropriate to the papers' context, such as number of citations, downloads, user base, concrete industrial exploitation, etc. Paper which has had a lasting impact on the field.	10–12 years	
Inter Assoc Cryptologic Research https://www.iacr.org/testoftime/ Intel https://www.intel.com/content/www/us/en/security-security-practices/security-research/hardware-security-academic-award.html	Outstanding novel research with a meaningful impact on the hardware security ecosystem and industry, including technologies created by Intel. • Significant and lasting impact in the security field.	15 years prior More than 10 years ago	Demonstrated how to generalize and scale the methodology. Greatly improved the ability to test critical system software. Incorporated several novel ideas at that time. New mitigation strategy Novelty which seems to be counterintuitive
Semantic Web https://swsa.semanticweb.org/content/swsa-ten-year-award	While citation count will be the primary criteria, the panel will also consider other impact factors for the top-cited papers.	10 years Award of 1000 euros	

(Continued)

Table 1. (Continued).

Organization	Criteria and selection process	Time Horizon of Award	Justifications for selection
FOCS https://tc.computer.org/tcmf/focs-test-time-award/#:~:text=The%20FOCS%20test%20of%20Time,broad%2C%20and%20currently%20relevant%20impact.	<ul style="list-style-type: none"> • Impact on Theory of Computing, or on Computer Science in general, or on other disciplines of knowledge, or on practice. • Substantial, lasting, broad, and currently relevant impact. 	10 conferences prior Or 20 conferences prior Or 30 conferences prior Nomination	
Supercomputing.org https://sc20.supercomputing.org/sc-test-of-time-award/ SIGMOBILE https://www.sigmobile.org/grav/awards/test-of-time-paper	<ul style="list-style-type: none"> • Deeply influenced the HPC discipline. • Mark of historical impact and recognition that the paper has changed HPC trends • Sustained and significant impact in the SIGMOBILE community over at least a decade 	10–25 years prior to the conference, Nomination 10+ years	Groundbreaking Ahead of its time Pioneering approach Revolutionized our understanding. Influenced industry and practice. Inspired our community. Closed important gaps between theory and practice. Demonstrated feasibility. Approaches are now standard practice. Experimental enabler

impact, opened further developments, inspired new research, novel ideas, and influenced practice. Organisations differ in determining eligibility and the specificity of criteria.

This summary table provided us with a solid set of criteria currently used by various organisations as the basis for selecting the ToT award-worthy publications in their field. In the next section, we present our analysis of this set by classifying them into common 'clusters' of criteria relevant for describing the research articles that made significant contributions to the advancements of the discipline which IFIP WG8.3 represents.

2.2. Contextualising ToT criteria for DSS publications

From this summary of the existing ToT criteria, it appears that the communities are looking at objective (mainly quantitative) as well as subjective (qualitative) criteria. The example of a quantitative criterion, for example, is the time horizon of review, which is most commonly suggested be 10 or more years. For the research area of Decision Support/DSS, which has to embrace and respond dynamically to technological innovations, it seems impractical to wait for 10 years to evaluate ToT impact. We also aimed to look at the impact of the paper(s) and topics, rather than acknowledge the contribution of the individual authors.

The other commonly used quantitative criterion is a number of citations or a variation of that in quantitative form. We acknowledge that the impact of research can be measured in various ways, hence we considered multiple aspects in our study. Although citation count is often misused in research output assessments, they have been widely used for nearly a century to indicate the impact of research (Bornmann & Daniel, 2008). Citation count is still a good proxy to the level of contribution and influence of the research on the academic community, but one must not forget that citation counts could be based on different citation databases (e.g. Google Scholar, Scopus, Web of Science, etc.) which may vary; moreover, mere numbers do not reveal whether citations were positive or negative, and older papers could accumulate more citations only due to their age (Wildgaard et al., 2014).

Recognising that the number of citations does not necessarily reflect on the quality of a work, Hicks et al. (2015, p. 430.) suggest that '... [q]uantitative evaluation should support qualitative, expert assessment' in their famous 'Leiden Manifesto'. Because we wanted to compare the impact of studies written across a 23-year lifespan, we had to finetune the simple measure of citation count. Therefore, we calculated the average citation per year measure to eliminate the handicap of the papers written later (recently published papers do not have the chance to receive as many citations as older ones). We looked more deeply at the other factors and selection criteria used by these organisations, and identified those which are relevant to the DS field (see analysis presented in Table 2). This analysis provided the basis for the proposed set of criteria for DS ToT selection as applied in this research.

Below we provide further justifications for the relevance of these clusters of criteria for the ToT assessment of the DSS research.

Table 2. ToT criteria relevant to the decision support research.

Clusters of ToT Criteria	Criteria explanations
Objective measure -CITATIONS	Citation count as the primary criterion Number of downloads Recent citations
Objective measure -TIME HORIZON	10 conferences Or 20 conferences Or 30 conferences prior by nomination 10+ years At least one decade
GENERAL/HOLISTIC and BROAD IMPACT - EXTERNAL	The quality and outreach of ideas Wide uptake - used/cited outside IFIP WG8.3 members Deeply influenced the DSS discipline. Deemed to be an outstanding paper and whose contents are still a vibrant and useful contribution today. Impact on several fronts, such as academic, educational, technical, industrial impacts Proposed the best practices in scholarly evaluation Principled foundation Probes deeper questions
INSPIRATIONAL/ COMMUNITY IMPACT - INTERNAL	Broad, and currently relevant impact Inspired new research within the community Seminal work taken as a reference to build further research on the DS area. Resurgence of interest and reflection Sustained and significant impact in the community over at least a decade Relevance for the real-time community (topic related to real-time conferences) Revolutionized our understanding Significant and long-lasting impact Longevity and influence of ideas
THEORETICAL IMPACT	Theoretical contribution on DS systems research Standardizes vocabulary Impact on theory in general, or on other disciplines of knowledge
PRACTICAL IMPACT	Solved outstanding issues Practical impact on the industry or potential impact Closed important gaps between theory and practice Influenced industry and practice Meaningful impact on the industrial ecosystem Experimental enabler Effect not only in the research community, but also within application domains Widely applied Opened further developments
NOVELTY/ORIGINALITY	Accessible framings Demonstrated feasibility Ground-breaking (i.e. artifact) First attempt, spawning new directions Novelty which seems to be counterintuitive Ushered in a new era Incorporated several novel ideas at that time Altered understanding Ahead of its time Outstanding novel research
METHODOLOGY/ APPROACH	Demonstrated how to generalize and scale the methodology Pioneering approach Approaches are now standard practice Innovative methodology Demonstrated feasibility Rigorous, new empirical study Novel, data-driven/analytics design and implementation Accessible framings Greater and deeper reflection (methodologically)

Objective measures:

- **CITATIONS:** Most ToT awards consider some objective measures at the evaluation of the papers. They measure academic impact mostly with citation count as the primary criterion, but they may also consider the number of downloads, or other more specific citation measures (for example recent citations).
- **TIME HORIZON:** Time horizon is another widely used objective criterion of ToT awards. Most of them consider only old enough papers that are really able to stand the test of time. The time horizon varies across the organisations we investigated, but it is always at least one decade.

Subjective measures based on holistic peer review assessments:

- **GENERAL/HOLISTIC and BROAD IMPACT – EXTERNAL:** ToT awards often consider papers that have demonstrated impact in various ways. This holistic approach usually assumes that these works influence both academia and practice, and they create interest even outside their narrower scholarly field.
- **INSPIRATIONAL/COMMUNITY IMPACT – INTERNAL:** Impact can be interpreted in a narrower way, i.e. to what extent the papers are relevant to the academic/professional community, and how they inspired new research directions in the given field.
- **THEORETICAL IMPACT:** Theoretical or scholarly impact to a certain extent is indicated by measures such as citation count, but some relevant, highly cited papers do not necessarily contribute to theory building. Therefore, a more subtle, subjective analysis is needed to see this level of contribution of ToT papers.
- **PRACTICAL IMPACT:** Although academic impact is an essential item in all ToT award criteria we looked at, they also put a great emphasis on the practical aspects. Applicability of the research findings seems to be critical in the field of decision support. Some criteria especially focus on how papers have a meaningful impact on industrial ecosystems, while others interpret this category more broadly.
- **NOVELTY/ORIGINALITY:** Papers that have stood the test of time are necessarily original, or at least discuss some novel aspects of existing concepts. Some ToT awards expect them to convey ground-breaking ideas that were born ahead of their times and might be even counterintuitive. In this sense these papers must demonstrate visionary approaches and findings.
- **METHODOLOGY/APPROACH:** Beyond original research areas, and ground-breaking ideas, most ToT criteria acknowledge innovative methodologies as well as academic rigour of the papers. Therefore, it is important *how* the results are delivered, not just *what* the findings are.

These measures require qualitative assessment by well-qualified panel of experts. Their evaluation process could be assisted by some decision-support models and tools to make their judgement more transparent and documented and reduce potential biases. For example, an Analytic Hierarchy Process (AHP) Model or some other multi-criteria decision-making models could be used as mechanisms for implementing such a decision support tool. Some examples of a variety of approaches are described by Olson (2008); Triantaphyllou (2000) and Pomerol and Barba-Romero (2000) and could be a starting point for implementing a DSS for a ToT assessment. Such multi-criteria models could integrate quantitative and qualitative criteria by using pair-wise comparisons if required.

3. Research method

We analysed past IFIP WG8.3 Decision Support conference proceedings as an opportunity to explore and validate the parameters of those impactful papers that could sustain the 'Test of Time' (ToT) in their contribution to the body of knowledge in the decision support field.

3.1. Procedure

Since the first conference in 1982, IFIP WG 8.3 has published a collection of conference papers as a set of proceedings. Each published set of proceedings was made available via the most appropriate and accessible media of the time. The early proceedings were available as hard copy books published by academic publishers, to edited books of proceedings published by a commercial publisher, electronic set of publication with ISBN on a CD only. From 2000 the proceedings were available via books and CDs, or sometimes as only CDs. Since 2016, the group has published its conference papers collections as a supplemental issue of the *Journal of Decision Systems* (JDS) which is published by Taylor & Francis and is made available online via academic subscriptions. This change of publication format dramatically improved accessibility of the papers presented in the conference.

The sample papers for our analysis were collected from the IFIP WG8.3 conferences proceedings since 2000. As the conference runs bi-annually this amounted to 12 sets of conference proceedings (from 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020 and 2022). The other consideration noted in the list of criteria relate to the substance and quality of the empirical results and a deeper reflection on the discipline. Since our analysis was based on the conference papers, it is normally not expected that such completed research results would be fully described in such a form of publication. Hence, we decided to capture whether the paper was subsequently [re]published independently of the conference proceedings. and a high-level characterisation of the paper type by research method. As previously mentioned, each bi-annual conference is assigned a theme, we identified the conference theme and associated keywords for the collection of paper analysed. Learning from this understanding, the research team progressed to select the sample of papers for further review using the method described in the next section.

The schema of selection analysis process is presented in [Figure 1](#). We completed the papers selection and analysis process following the steps presented in this diagram in September 2023. Each co-author reviewed and analysed three collections of proceedings and the team met as a group online in early October 2023 to discuss and refine the results.

Notably, some discussion took place around a small subset of papers that had been published as full journal papers in another outlet. It was agreed that papers that were cited as separate and independent journal publications were removed from the final collection of 21 papers (see [Appendix 1](#) for the total list).

3.2. Data analysis strategy

Accepting the considerations as presented in section 2.2, we relied on a citation count as a starting point for inclusion in the sample, together with the following factors as part of our analysis instrument:

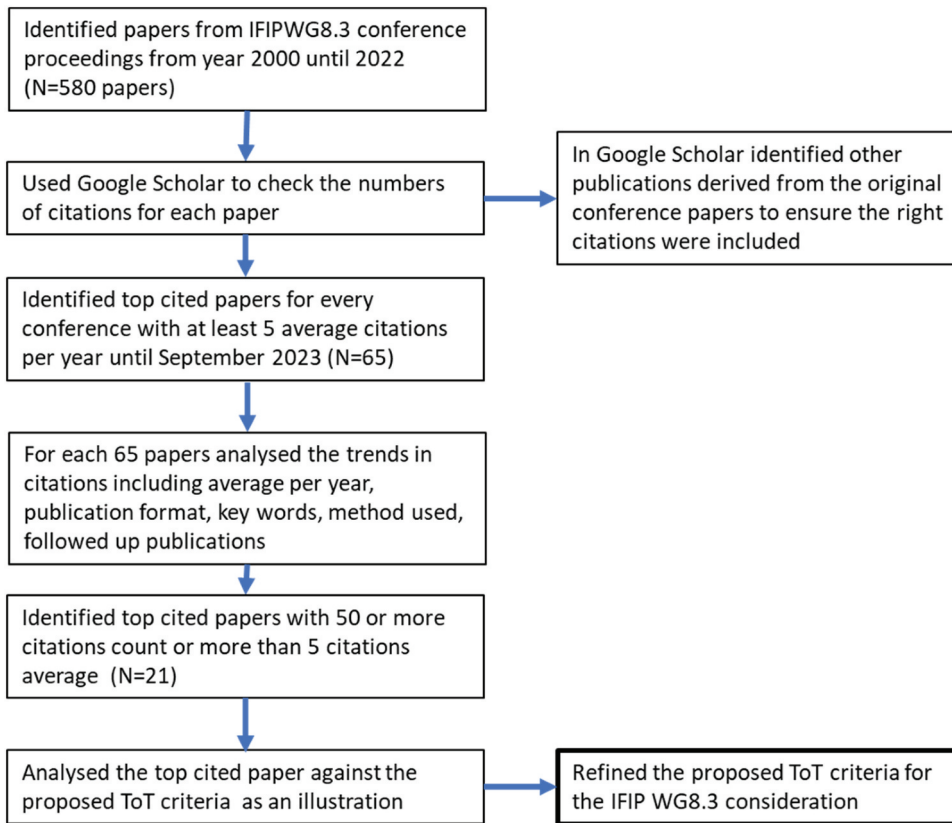


Figure 1. Paper selection and analysis process schema.

- (1) Number of total citations for papers from the 2000–2022 conferences proceedings had to be not less than 50 or average citations per year more than 5;
- (2) The paper has a follow-up publication – Y/N;
- (3) Research method used in the paper [literature review, empirical/case study, design science, conceptual/theoretical];
- (4) Keywords;
- (5) Conference theme and a format of the published proceedings for this conference.

We've included keywords as an indicator of GENERAL/HOLISTIC and EXTERNAL/BROAD IMPACT (see section 4.2 for description of the results). The summary of the classification of the papers are included in the [Appendix 1](#).

4. Results of analysis

We present the analysis of the 21 papers (see [Appendix 1](#)) through the lens of the criteria outlined above. This provides a starting point to explore Test of Time as a measure of research impact in our community. First, we consider citations as an objective metric of impact. Next, we reveal some of the 'hot topics' at various intervals over the last 23 years

and we establish how the IFIP WG8.3 research community has engaged with these, and other factors identified as contributing to make the research noted internally and externally.

4.1. Citation analysis

The analysis demonstrated that most of the papers published in hard copies were not cited or not even discoverable on-line through a Google Scholar search. This was particularly true for the papers published in hard copy proceedings and/or CDs. Figure 2 shows publications from the original sample which made it into the 65 top cited papers.

The move to the JDS supplemental has definitely improved the visibility of the publications as evidenced by a steady level of citation of papers published at the consecutive conference including the last one which was held in 2022 in Hungary.

Notwithstanding the fact that the topics of the conferences and the quality of papers should have a definite effect on the citations, the format and accessibility to a wider readership contributes to the exposure of the research seems to be important (see cumulative citation by the type of proceedings presented in Figure 3).

Interestingly, IFIP WG8.3 papers published in past JDS supplementary issues (as proceedings) are amongst the most highly cited and downloaded papers in the journal. There appears to be multiple benefits arising from the association between the conference and the journal.

4.2. Relevance of IFIP WG8.3 conference topics - key words analysis

Google Trends is an online tool for the comparison of the popularity of terms searched by general users of Google Search, and their trends over time by location. Google Trends was used to create a context for keyword searches related to IFIP WG8.3 conference themes

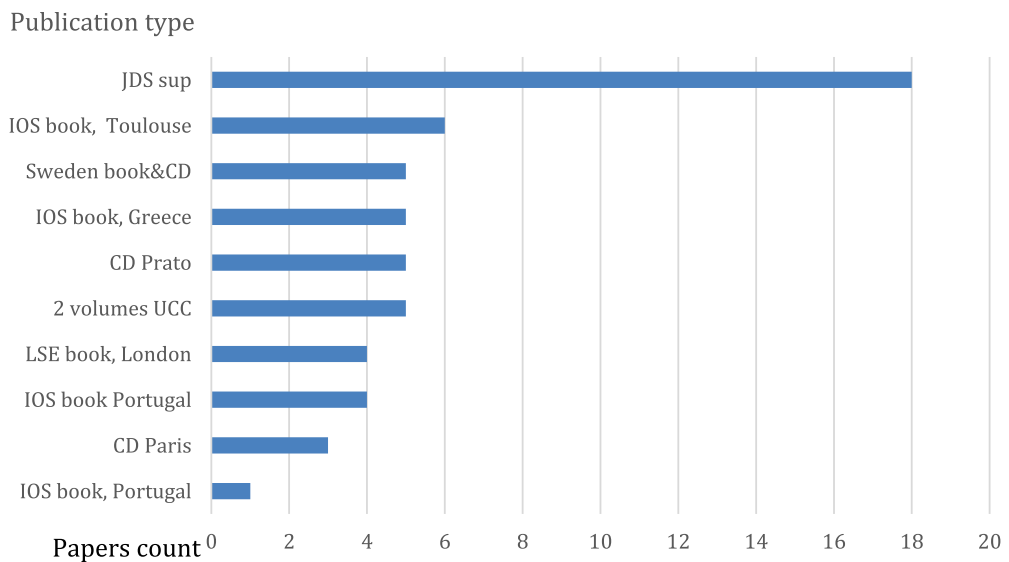


Figure 2. Papers count and format for proceedings.

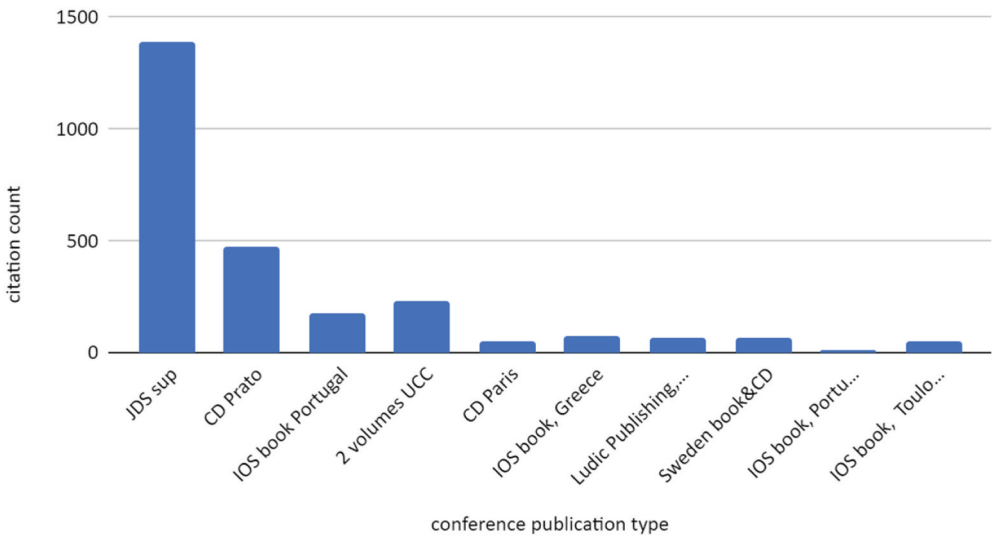


Figure 3. IFIP WG8.3 conference proceeding citation total by publication format.

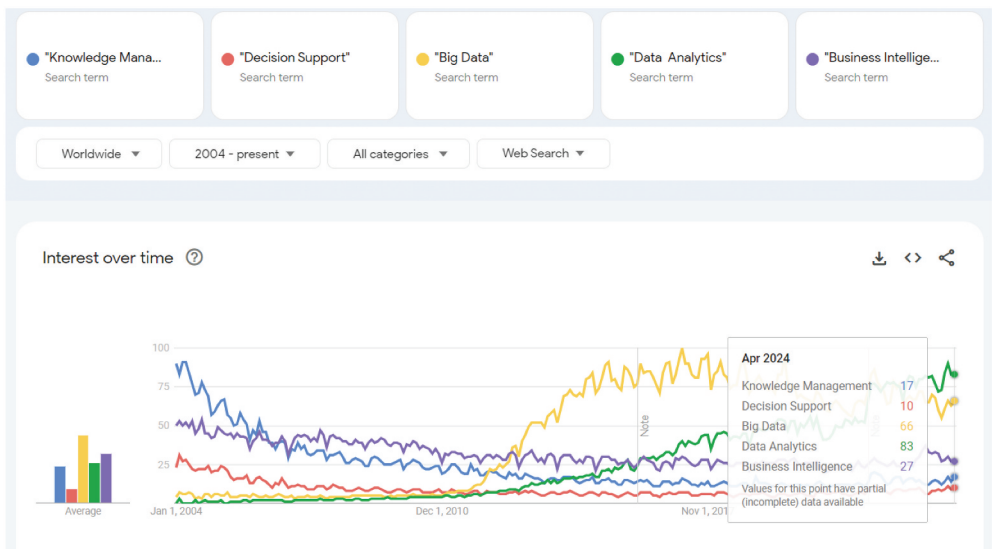


Figure 4a. Google search analytics trends - January 2004- April 2024.

from 2004 to 2022, focusing on “Decision Support Systems” and related terms starting from 2004 when the search data time series began.

Figure 4(a,b) depict the relative number of searches for the terms ‘Knowledge Management’, ‘Decision Support’, ‘Data Analytics’, ‘Big Data’, ‘Digital Transformation’, and ‘Business Intelligence’ between January 2004 and April 2024.

Comparing the Google Trends search term results with the IFIP WG8.3 conference themes (see Table 3), it can be seen that the research efforts of the group fit widely searched IS/Decision Support related keywords at specific periods in time.

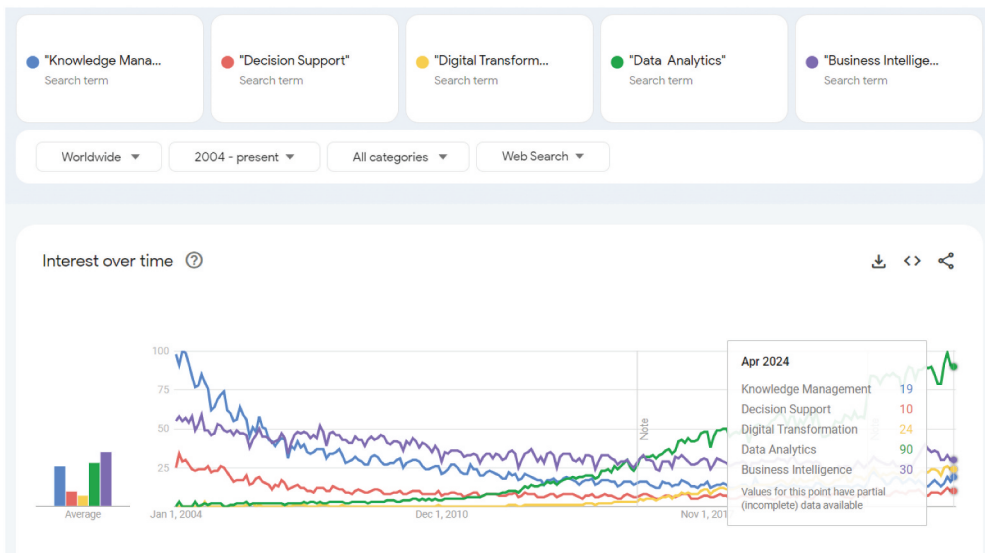


Figure 4b. Google search analytics trends April 2024 - including the search term “digital transformation”.

Table 3. IFIP WG8.3 conference themes since 2000.

Year	Conference theme
2000	Knowledge Management
2002	Decision support systems in the Internet Age
2004	Decision support in an uncertain and complex 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 Decision Support Systems 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	Decision Support Toward enhanced risk management, shaping risk culture theory and making sound decisions under pressure
2022	From Data Analytics to Intuition: DM continuum from human-centric DM approaches to analytics-based DM approaches

While ‘decision support systems’ as an exact topic is not gaining more popularity over the last 20 or so years, the related terms like ‘Knowledge Management’ has steadily declined in popularity; instead ‘Big Data’, ‘Digital Transformation’, and ‘Data Analytics’ continue to gain more and more attention globally among Google users.

Further, the increasing focus on ‘analytics’ related topics justifies the recent movement, for example, of the Association of Information Systems Special Interest Group for Decision Support Systems to add analytics as its focus and its change of name to SIGDSA (Special Interest Group on Decision Support and Analytics) in 2014. The SIG renaming marked a significant transition to what we now consider the modern era of analytics (Keenan & Heavin, 2022).

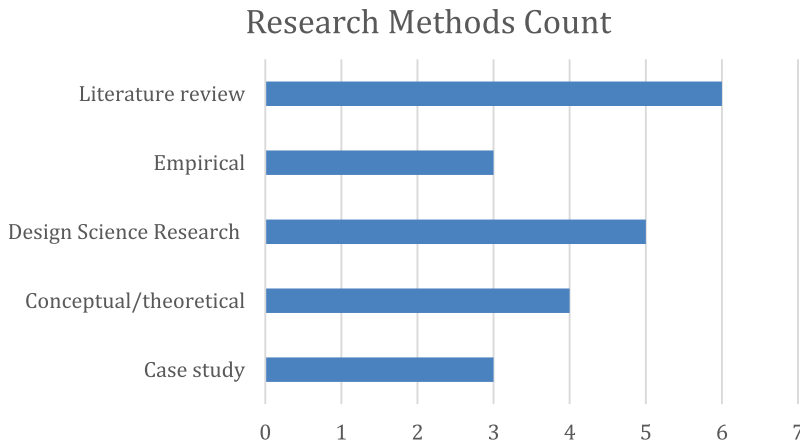


Figure 6. Types of research methods by frequency from top cited articles IFIP WG 8.3 2000–2022.

4.4. Applying the ToT criteria to the selected example

To illustrate how the proposed ToT criteria can be applied for evaluation of the IFIP WG8.3 papers, we selected the paper entitled '*Challenges for digital transformation – towards a conceptual decision support guide for managers*' (Heavin & Power, 2018) as it was identified as the most cited article (Google Scholar citations – 336 as of October 2023) in our sample. The team of authors of this paper applied the proposed ToT criteria to assess this paper and arrived at consensus on relevance of the quantitative and qualitative measures to its content.

This conference paper was presented at the IFIP WG 8.3 2018 Open Conference in Ljubljana, Slovenia. The conference theme was '*DSS Research Delivering High Impacts to Business and Society*'. This paper was published as part of the conference supplemental of the Journal of Decision Support. It has been viewed 18,095 times; it is currently the most cited paper published in JDS. As of late 2023, this paper will be published almost six years with an average annual citation count of 67 citations. The IFIP WG 8.3 have organised three conferences since the publication of this paper in JDS.

This paper was timely and relevant for the Decision Support and wider research and practitioner community (INTERNAL and EXTERNAL IMPACT) in terms of engaging with the concept of Digital Transformation (DT) for managers, as well as external community to IFIP WG8.3. This paper was presented at a time when DT was beginning to gain momentum in the academic literature while also being cited as a key technology trend by international technology market analysts. The authors draw on existing, seminal literature to propose common DT challenges facing managers. From a theoretical/conceptual perspective, the researchers leverage the 'traditional view' of an organisation drawing on the accessible framing of operational, tactical, and strategic level tasks in an effort to provide both a theoretical lens to conceive DT in organisations, as well as offering practical guidance to managers responsible for DT programmes. In doing this, this paper endeavours to standardise the terminology used vis-a-vis the challenges experienced by managers 'doing' DT. In terms of SCHOLARLY IMPACT, the selected paper has been cited in journal papers published in high calibre peer reviewed international business and technology

journals, for example the Journal of Business Research (IF = 11.3), Journal of Information and Management (IF = 9.9), and Technology in Society (IF = 9.2).

This exercise demonstrated applicability of the set of criteria when it comes to explaining the value of the publication long-term. It also showed that some criteria were more relevant to it than the others.

5. Discussion

There is clear evidence that the papers presented at the regular IFIP WG8.3 conference are making a sound impact by way of being cited in diverse and influential publishing outlets. The conference presentation and proceedings provide the DS community with a testbed to sound out novel ideas often as more early stage theoretical/conceptual research and empirical work. Thus, playing a vital role in advancing knowledge, promoting collaboration, and contributing to the public good by fostering innovation that can lead to the generation of impactful projects and initiatives.

The analysis of a sample of the conference proceedings was a useful exercise to evaluate and reflect on the impact that this community has been aspiring to in the past 25 years. A set of criteria for ToT evaluation is summarised in Table 4. Our analysis should help to define and shed light on what makes a difference in the discipline over a long period of time. Our investigation demonstrated that a few of the papers presented in our conferences, as the first attempt of generating discussion and collecting some feedback, have been consequently published as journal papers and attracted wide attention and many more citations correspondingly. For example, the publications by Zhuang et al. (2006)

Table 4. Proposed criteria defining a ToT for IFIP WG8.3.

Criteria	Definition/assessment process	Justification
TIME HORIZON	Five years	Reflection of the impact of the research between consecutive conferences.
CITATIONS	Cumulative number of citations and downloads	Used by other ToT awards to measure breath of impacts as well as the measure of Internal and External impact.
AVERAGE CITATION PER YEAR	Ratio of total citations over the number of years since publication	A measure to normalise the rate of citations between the new publications and those published in earlier years.
GENERAL/HOLISTIC and BROAD IMPACT - EXTERNAL	Highly cited systematic reviews/ conceptual papers	Foundational value to ground future research by placing it within a research stream.
INSPIRATIONAL/COMMUNITY IMPACT - INTERNAL	Case studies/experiments	Possibility of affecting practice and encouraging theory to explain the results.
THEORETICAL IMPACT	Highly cited conceptual papers Expert speculation.	Foundational value to underlie empirical results, standardize terminology in the field and often leading to extensions of the theory.
PRACTICAL IMPACT	Highly cited empirical papers. Strong application value. Closes important gaps between theory and practice.	Forms linkage between theory and practical application.
NOVELTY/ORIGINALITY	Thought experiments. Design Science Research. Opinion articles.	Reflections and opinions of members of the community.
METHODOLOGY/ APPROACH	Innovative methodology. Standardises methods and/or processes of investigation.	Demonstrates systematic processes that can be used by others to investigate a topic.

attracted more than 100 citations including its later version published in the European Journal of Operational Research (see Zhuang et al., 2009). The other example is the paper by Arnott and Pervan on key issues for the DSS discipline; it was published originally as a conference paper in 2006 proceedings published by London School of Economics and is not even discoverable from Google Scholar search with no citations to this version. However, its later version was published in 2008 in the Journal of Decision Support Systems and attracted more than 500 citations. Thus, it could be considered as a potential contestant for a ToT award due to the introduction of the fundamental ideas at an IFIP WG8.3 conference (see Arnott & Pervan, 2008). We found that a few papers fall into this category and the citations attracted by subsequent journal papers outnumbered the initial conference paper citations by far. It is still noteworthy to include such publications as examples of those making an impact to the ToT as they were generated from the initial ideas presented at the IFIP WG8.3 conference.

As demonstration in the described example, these criteria may not be applicable in full for every paper identified as reaching the ToT targets. However, we illustrated how relevant they are to the top cited paper identified out of analysis of 12 conference proceedings from 2000 to 2023.

6. Conclusion

The ToT criteria analysis of the 23 years of publications of the IFIP WG8.3 open conference demonstrated that, in no particular order:

- (1) Number of citations is not necessarily the best reflection of the impact of a paper in the long term.
Citation count as a sole measure to evaluate scientific impact has been criticised recently by various scholars of scientometrics (Migheli & Ramello, 2021). A deeper qualitative analysis of the citing papers is needed to reveal the real scientific impact of a publication.
- (2) Technology changes rapidly, so time could be judged as near-term. Average per year citation is a better indication of impact in technology.
Recent papers, for example, cannot accrue a high number of citations due to the short time that elapsed since publication, while older top-cited publications might be stereotypical, that is, researchers do not question their importance (Ioannidis et al., 2014). Using average citation per year as an indicator may help to overcome this burden, but it neglects the findings of many studies. For example, citations are not equal, and many of them are perfunctory (Zhu et al., 2015).
- (3) Most papers were not re-published in journals, but those that appeared as journal publications were more visible to an external audience. In addition, papers that were extended included more material to make a higher external impact and, as a result, were cited more often in the long term.
- (4) The conference topics were well aligned with the research trends of that time – hence, the papers which addressed those topics were more visible and made broader external and internal impact.

For early career researchers and doctoral students, it is useful to consider where their results would be best published to boost their academic career and build a research profile.

A conference with the proceedings published in a journal of high reputation and ranking provides a good springboard to attract the attention of the research community. In the past 25 years IFIP WG8.3 made a positive move in this direction. Later stage researchers should consider investing some time in developing early formulations of theory or methodology through conference papers that may be commented upon by attendees and extended to full journal papers. In addition, conferences should be open to new ideas and opinion pieces by credible members of the community.

In practice, this analysis highlights that further investigation of published conference papers could present useful material for formulating potential topics for future conferences. A well-chosen conference theme can lead to idea generation and result in impact in the community or 'greater good'. In addition, a few conceptual studies that were conducted and included in the proceedings shed light on definitional issues which could serve as topics for panel discussions or further theoretical investigations.

We recognise some limitations in our study. We investigated only one body of research arising from the IFIP WG8.3 Decision Support conference. The justification for our choice was that this research area is well-defined and established, and the conference organisation has long-standing practices. We were able to evaluate the effect of changes in the community and in publication venues over a fairly long period of time. The results could be applied with care to other situations with different circumstances and accepted research practices. In conclusion, we argue that by applying ToT criteria the IFIP WG8.3 community could work towards a 'seminal' set of publications that could be justified from one or several of these criteria. The process of such an evaluation will create a valuable resource or readings for doctoral students and early career researchers in the field of DS and analytics. We invite the IFIP WG 8.3 to engage in the process of evaluating and nominating such papers in the near future.

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No potential conflict of interest was reported by the author(s).

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Appendix 1 8.– IFIP WG3 Top Cited articles 2000-2022*)

* - includes papers which were subsequently republished, which were not included in the further analysis due to the combined citations numbers.

Reference	authors	year	Citation count	Avg. cit/year	Keywords	Conference publication type	Republished Y/N?	Methodology
Challenges for Digital Transformation – Towards a Conceptual Decision Support Guide for Managers	C Heavin, DJ. Power	2018	336	67	Digital transformation, challenges, dilemmas, decision support guide, managers	JDS sup	n	Literature review
Evaluating the Intangible Benefits of Business Intelligence: Review & Research Agenda	M Gibson, D Armott, I Jagielska	2004	196	10	Business intelligence (BI), evaluation, decision support systems (DSS), intangible benefits.	CD Prato [Available at ResearchGate]	n	Conceptual/theoretical
An integrated patient journey mapping tool for embedding quality in healthcare service reform	S McCarthy, P O'Raghallaigh, S Woodworth, Yoke Lin Lim, L C. Kenny, F Adam	2016	175	25	healthcare service, modelling, design science, patient experience	JDS sup	n	Literature review
Data governance activities: an analysis of the literature	I Alhassan, D Sammon, M Daly	2016	163	23	Data governance: data governance activities; content analysis; open coding	JDS sup	n	Literature review
Business Analytics and Competitive Advantage: A Review and a Research Agenda.	R Sharma, P Reynolds, R Scheepers, P Seddon, G Shanks	2010	111	9	business analytics, data warehouse, data analysis, performance gains, competitive advantages, dynamic capabilities	IOS book Portugal	n	Case study
Combining data mining and case-based reasoning for intelligent decision support for pathology ordering by general practitioners in Australia	Z.Y. Zhuang, L. Churilov, F. Burstein, K. Sikaris	2006	144 [combined]	8	data mining, knowledge discovery, case-based reasoning, pathology ordering, general practice.	LSE book, London	Y	Design Science Research EJOR journal paper
An Ontology for Developing E-Business Models	A Osterwalder, SB Lagha, Y Pigneur	2002	108	5	e-business, e-business model, e-business model design, ontology	2 volumes UCC	n	Design Science Research

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Reference	authors	year	Citation count	Avg. cit/year	Keywords	Conference publication type	Republished Y/N?	Methodology
Social media as a support for learning in universities: an empirical study of Facebook Groups	L Ahern, J Feller, T Nagle	2016	107	15	social media; higher education; information and decision-making needs; motivations	JDS sup	n	Empirical
Decision making under stress: the role of information overload, time pressure, complexity, and uncertainty	G Phillips-Wren, M Adya	2020	94	31	Decision making; stress; information overload; time pressure; complexity; uncertainty; decision quality	JDS sup	n	Design Science Research
'Big Brother' can watch us	D.J. Power	2016	86	12	Big Brother; big data; predictive analytics; social media; surveillance; thought control; totalitarian government	JDS sup	n	Case study
Workers' technostress: a review of its causes, strains, inhibitors, and impacts	A Shifia Nisafani, G Kiely & C Mahony	2020	84	28	Technostress; literature review; technostress causes; strains; technostress inhibitors; technostress impacts	JDS sup	n	Literature review
Managing social media uncertainty to support the decision-making process during Emergencies	S Planella Conrado, K Neville, S Woodworth & S O'Riordan	2016	72	10	Social media; decision making process; verification; emergencies stakeholders; emergency management	JDS sup	n	Conceptual/theoretical
Explainable predictive business process monitoring using gated graph neural networks	M Harl, S Weinzierl, M Stierle, M Matzner	2020	66	22	Predictive business process monitoring; explainable artificial intelligence; gated graph neural networks; decision support system; deep learning	JDS sup	n	Literature review
A Decision Support System for Technology Selection in Software Production	S Farshidi, S Jansen, R de Jong, S Brinkkemper:	2018	61	12	decision-making; decision support system; technology selection; database management system	JDS sup	y – IEEE Conference paper	Literature review
Decision Support for Supporting Sustainable Waste Management	O. Rybnytska, F Burstein, AV. Rybin, A Zaslavsky:	2018	36	7	Pervasive computing; decision support system; sustainability; smart waste management	JDS sup	n	Design Science Research

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(Continued).

Reference	authors	year	Citation count	Avg. cit/year	Keywords	Conference publication type	Republished Y/N?	Methodology
Evaluation of several approaches for deriving weights in fuzzy group analytic hierarchy process	P. Grošelj, L. Zadnik Stim	2018	34	7	Fuzzy analytic hierarchy process; triangular fuzzy numbers; soft consensus; extent analysis method	JDS sup	n	Conceptual/theoretical
IoT-based Decision Support System for Monitoring and Mitigating Atmospheric Pollution in Smart Cities	A Miles, A Zaslavsky, C Browne	2018	30	6	traffic management; atmospheric pollution; air quality management; mitigation measures; modelling framework	JDS sup	y (JETA 2015)	Design Science Research
Intuition in decision making – Risk and opportunity	F Adam, E Dempsey	2020	22	7	Intuition; risk; decision making; rationality; evidence-based; healthcare; delivery room	JDS sup	n	Case study
Exploring the effect of context information on deep learning business process predictions	J Brunk, J Stottmeister, S Weinzierl, M Matzner, J Becker	2020	20	7	Predictive process monitoring; deep learning; context-sensitivity	JDS sup	n	Conceptual/theoretical
'Doing' digital transformation: theorising the practitioner voice	P McCarthy, D Sammon, I Alhassan	2022	6	6	design, design science.	JDS sup	n	Empirical
Challenges in research data management practices: a literature analysis	G Birkbeck, T Nagle, D Sammon	2022	6	6	Research data management; literature review; grounded approach; data governance; challenges	JDS sup	n	Design science Research
Crowdsourcing Analysis of Government Expenditures: The Case of Armchair Auditors	Dan O'Leary	2014	50 [combined]	6	armchair auditing; crowdsourcing; open data; e-government; auditing	IOS book/CD Paris	y (JETA 2015)	Conceptual/theoretical
Algorithm aversion? On the influence of advice accuracy on trust in algorithmic advice	S Daschner, R Obermaier	2022	5	5	Algorithm appreciation; cognitive trust; initial trust; Perfect Automation Scheme; trusting beliefs; Advice Accuracy; Forecasting	JDS sup	n	Empirical