# Re-imagining Technology Adoption Research Beyond Development and Implementation: ITOps as the New Frontier of IS Research

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**Abstract.** IT operations (ITOps) is a key function in IS organisations. To manage and ensure the availability and reliability of the plethora of new/emerging and complex technologies that organisations increasingly adopt, ITOps had undergone significant changes and is currently going through major transformations. This paper assesses the current status of ITOps research. It reviews the literature across the AIS basket of eight journals, specifically over the last four decades. The analysis highlights the key areas in need of updating and research effort. The paper concludes that ITOps is ripe for further research and it is timely for IS research to update its knowledge base on the management of IT including ITOps, considering the significance of emerging technologies in the IT landscape.

**Keywords:** IT adoption · IT operations · ITOps · IT infrastructure · IT availability · IT reliability · Predictive maintenance · Data analytics

## 1 Introduction

Information systems adoption and diffusion research covers a broad area, from conceptualisation to development through to use and operations (Dwivedi et al. 2010). Whilst much of IS adoption research focuses on development and use, keeping IS operational; i.e. available, reliable, resilient and responsive to users after initial installation is critical to organisations. However, it is widely recognised as expensive (Swanson, 1999, Tambo and Filtenborg 2019). It consumes over half of IS implementation costs and IT decision-makers are under pressure to further escalate spending on IT systems and services, to ensure operational continuity and success (Reisinger 2013; Tsunoda et al. 2017). It is also challenging, as transitioning IT from development to operations involves complex technological and organisational processes, various stakeholders/teams and a wide range of technologies that offer round the clock system monitoring and real-time interactions between different organisational functions.

It also involves a wide range of activities including system maintenance, configuration management, change/risk management, incident management, service management, process management, customer support, system audit, tools management and knowledge/skillsets management (Abeck and Mayerl 1999; Taylor et al. 1997;


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Edwards 1984; Banker and Slaughter 2000; Krishnan et al. 2004; Nelson et al. 2000; Shaft and Vessey 2006). Thus, as a function, IT operations (ITOps) constitute a complex knowledge ecosystem involving several social and technical domains (Ramakrishnan et al. 2018), and is considered as one of the dynamic capabilities that help organisations to rely on IT for business (Cetindamar et al. 2009).

Currently, ITOps is undergoing major transformation including deployment of AI, IoT, digital platform technologies, data analytics and intelligent software, in addition to new methodologies like DevOps. In this regard, the ITOps management market increased by 10% in 2019 from the previous year to over $30 billion and the IT performance analysis software market also reached over $12 billion (Gartner 2020). Importantly, ITOps have shifted from domain-centric applications that focus on one area like network traffic to a more product-centric and services view that show the impact of application performance on end-users and business outcomes (Gartner 2020).

Considering its importance in keeping IT operational and the on-going transformation in the domain, this study assesses the status of research in ITOps. It questions how ITOps had been treated and which aspects had been studied? To answer these questions, we reviewed relevant articles in the AIS Senior Scholars Basket of eight journals from 1980 to 2020. This revealed the extent of ITOps research and provided grounds for suggesting future research. The rest of the paper is structured as follows. Section two presents an overview of the key aspects of ITOps followed by a description of the research method. A summary of the findings and discussion on their implications for future IS research is then presented. The paper then concludes by noting that it is timely to update the knowledge base of ITOps and the management of IT.

## 2 IT Operations

### 2.1 Key Aspects

ITOps is responsible for the smooth functioning of IT infrastructures and the operational environments that support IT service delivery and application deployment, including network management and customer support (Hetvik 2014). It is part of IS life cycle and follows the IS development phase as depicted in Fig. 1 below.

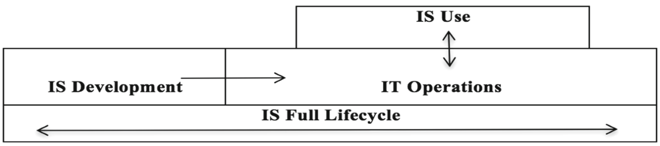


**Fig. 1.** Relationship between IS development and operations

ITOps thus cover a wide range of knowledge base and activities that could be categorised into day-to-day operational tasks, problem-solving/error handling and processing user change requests (Abeck and Mayerl 1999). Day-to-day operational tasks include system and user support. Problem-solving tasks include error detection/troubleshooting, incident management, software code validation, system audit and corrective/adaptive maintenance. Processing user change requests include attending to service complaints and performing preventive maintenance to address risks. They could also be categorised as technical, application development and system maintenance (Nelson et al. 2000). Technical tasks include system configuration and capacity management. Application development tasks include requirement analysis and validation. System maintenance tasks include adaptive, corrective and preventive maintenance. ITOps tasks had also been categorised as proactive, preventive and reactive (Jamieson and Low 1990; Caralli et al. 2010). Proactive tasks include system performance monitoring and process management. Reactive tasks include incident response and emergency changes. Table 1 enumerates the differences between IS development and ITOps.

**Table 1.** Differences between IS development and operations

| | IS development | IT operations |
|---|---|---|
| 1. | Responsible for IT design and development by producing new artefacts | Responsible for operating old/new IT Also retires legacy/defunct artefacts |
| 2. | Delivers new IT artefacts to operations to run in production | Receives new IT artefacts from development to run in production |
| 3. | Focus on producing new technical artefacts/systems | Focus on running existing systems at optimal levels and non-stop |
| 4. | Design and builds technical artefacts in non-prod environment | Manages and troubleshoots failures in systems designed by others |
| 5. | Commissions a small group of users to test system functionality | Services are deployed to a large constituent of end-users |
| 6. | Failures in functionality may be oblivious to end-users as there are no SLAs | Live services are strictly monitored and active SLAs, SLOs or OLAs are in place. |
| 7. | Focus on developing one or few systems/services at a time. | Operates and manages multiple systems/services at any given time |
| 8 | Teams competence focus on emerging/new technologies | Teams competence focus on both established and emerging technologies |
| 9 | Recognised project delivery models are followed to produce new artefacts | Best practices and good judgment facilitate reliable system operations |
| 10 | Requirements are well-defined | Requirements are fuzzy |
| 11. | Does not operate the technical artefacts they design and develops | Operates technical artefacts that were designed and developed by others |
| 12 | Tolerant non-production environment for development activities | Unforgiving production environment with live systems running |
| 13 | Could easily modify or discard problematic artefacts as user-base is small | Tedious troubleshooting of artefacts and services to support growing user-base |

(*continued*)

**Table 1.** (*continued*)

| | IS development | IT operations |
|---|---|---|
| 14 | Developments are often time bounded and budgeted for in advance | Tasks are difficult to budget for in advance and incidents are common. |
| 15 | Working hours are usually sufficient since, services are not live | Round the clock coverage of live services, as failure could occur anytime |
| 16 | Failures are predictable and could wait for next available engineer | Instant failure detection, tracking and management are required |
| 17 | Configuration changes/upgrades are often planned in advanced | Configurations changes/upgrades may be urgent to counter failures |
| 18 | Tasks are often linear/clearer | Tasks are often non-linear/complex |
| 19 | Success/failure are predictable | Success/failures are unpredictable |
| 20 | Development of artefacts could be cancelled without impact on users | Abandoning production systems/artefacts have implications for users |
| 21 | Performance benefits could be projected with relative ease | performance benefits are difficult to predict due to mix of old/new kits |
| 22. | Artefact development strategy and design could easily be changed | Artefact designs are inherited from development and thus locked-in |

In practice, ITOps is guided by industry frameworks like ITIL, COBIT, ISO27000, TOGAF and Six Sigma (Herrera and Van Hillegersberg 2019) that focus on processes, procedures and governance. Although, organisations are increasingly paying more attention to automation and optimisation to improve reliability and control costs.

## 2.2 Organisational Reliance on ITOps and Its Critical Importance

As organisations and society increasingly rely on complex IT systems and infrastructures, ITOps had become more critical. The financial and social losses that are experienced during IT failures compel organisations to invest more in ITOps. There is an abundance of cases where IT outages had resulted in millions of dollars in loss. These include many high profile cases like WhatsApp's global IT outage in July 2020, Lloyds Bank's IT outage in January 2020, Travelex's global IT outage in January 2020, Delta, Southwest, American Airlines' IT outage in December 2019, Sydney trains' IT outage in February 2019, Air India's IT failure in April 2019, Amtrak's Signal System Failure in March 2019, Amazon's IT outage in June 2019, Google's login system outage in April 2019, Visa's IT outage in June 2018, Microsoft's Azure outage in September 2017 and New York Stock Exchange's IT outage in July 2015. Table 2 presents three cases in the UK to highlight the scale of negative impact and financial loss.

**Table 2.** Financial costs of three recent incidents in the UK

| IT Incident | User impact | Financial impact |
|---|---|---|
| 1. RBS IT incident in June 2012 (Financial Conduct Authority 2014) | – 6.5 million customers were unable to access ATMs and online accounts<br>– Prevented some from making timely mortgage payments<br>– Prevented business account holders from honouring their payroll | – A total of £42 million fine was imposed on RBS, NatWest and Ulster Bank by the UK's financial regulator (Financial Conduct Authority 2014) |
| 2. TSB IT incident in April 2018 (Financial Times, 2018) | – Botched migration of database affected 1.9 million customers who lost access to online bank accounts<br>– Business accounts were unable to fulfil payroll responsibilities on time<br>– CEO resigned (BBC News, 2018b) | – FCA enquiry (BBC, 2018c)<br>– Compensation for customers totaling £176.4 million (TSB Bank, 2018), including cancelling £10 million overdraft fees and interests worth £30 m |
| 3. O2 and Ericsson IT Outage in Dec 2018 (Reuters 2018, Ericsson 2018) | – 25 million O2 and 7 million Sky, Giffgaff & TalkTalk data customers<br>– 8,500 time schedule displays on London buses (Bloomberg 2018)<br>– 11,500 bikes connected to O2 payment terminals (Bloomberg 2018)<br>– Deliveroo (Bloomberg 2018) | – Projected compensation of about £100 million from Ericsson (Telegraph 2018)<br>– Offered 2 days air time credit for contract holders and 10% off credit for affected pay as you go users (BBC News 2018a) |

## 3 Methodology

To address the research question, we conducted a literature review that focused on publications from 1980 to 2020. Whilst selection of journals play a key role in the assessment of past research, "there are no established criteria that govern the choice of journals" (Robey et al. 2008; Straub 2006). However, we followed Robey et al. (2008) criteria of selecting IS journals based on reputation in the IS field. Hence, we selected the AIS senior scholars' basket of eight journals that are recognised for their rigorous review processes. This includes MISQ, ISR, JIT, JMIS, EJIS, JAIS, JSIS and ISJ.

We identified the initial set of articles through a combination of title, keyword and abstract searches, as well as reviews of research questions. We used keywords like IT operations and maintenance to search. The inclusion criterion was for the papers to directly examine an aspect of ITOps. This approach yielded 29 papers from the basket of eight IS journals. Table 3 shows a breakdown of the reviewed papers.

**Table 3.** IT operations literature organised by Journal (between 1980–2020)

| Journals (AIS Basket of Eight) | No. of Papers | Percent |
|---|---|---|
| MIS Quarterly (MISQ) | 7 | 24.14% |
| Information Systems Research (ISR) | 4 | 13.79% |
| Journal of Information Technology (JIT) | 6 | 20.69% |
| Journal of Management Information Systems (JMIS) | 6 | 20.69% |
| European Journal of Information Systems (EJIS) | 5 | 17.24% |
| Journal of the Association for Information Systems (JAIS) | 1 | 3.45% |
| Journal of Strategic Information Systems (JSIS) | 0 | 0 |
| Information Systems Journal (ISJ) | 0 | 0 |
| **Total** | **29** | **100%** |

Regarding analysis, we identified and analysed articles in two phases. In the first phase, we distilled the activities associated with ITOps and identified ten broad categories. We then classified the 29 articles based on these.

**Table 4.** IT operations literature organised by research theme (between 1980–2020)

| ITOps aspects | 1980s | 1990s | 2000s | 2010s | Percent |
|---|---|---|---|---|---|
| 1. System Maintenance | (Edwards 1984), (Kim & Westin 1988), (Ives & Vitale 1988), (Rozensh-tein & Minsky 1986) | (Dekleva, 1992), (Dekleva & Drehmer 1997), (Hipkin, 1996), (Tan & Gable, 1997), (Kaasbøll, 1997) (Moreton, 1990) | (Swanson & Dans 2000), (Krishnan et al, 2004), (Banker & Slaughter 2000), (Min Khoo & Robey 2007), (Shaft&Vessey 2006) | (Choudhary & Zhang 2015), (Dennis et al. 2014), (Edberg et al. 2012) | 18 (62.1%) |
| 2. Config Management | | | | | 0% |
| 3. Change/Risk Management | | | (Goldstein et al. 2011) | | 1 (3.5%) |
| 4. Incident Management | | | | | 0% |
| 5. Service Management | | (Rands, 1992), (Griffin & Sumichrast, 1994) | | (Wiedemann et al. 2020) | 3 (10.3%) |

(*continued*)

**Table 4.** (*continued*)

| ITOps aspects | 1980s | 1990s | 2000s | 2010s | Percent |
|---|---|---|---|---|---|
| 6. Process Management | (Paddock, 1985) | | | | 1 (3.5%) |
| 7. Customer Support | | | | | 0% |
| 8. System Audit | | (Jamieson & Low 1990) | | | 1 (3.5%) |
| 9. Tools Management | (Moreton, 1992) | | | | 1 (3.5%) |
| 10. Knowledge/Skillsets Management | (Goldstein 1989) | (Taylor et al. 1997); (Shaft & Vessey 1998) | (Nelson et al, 2000) | | 4 (13.8%) |
| **Percent** | **7 papers (24.1%)** | **11 papers (37.9%)** | **7 papers (24.1%)** | **4 papers (13.8)** | **29 (100%)** |

In the second phase, all the 29 articles were re-categorised by publication year/decade to glean insight into whether particular aspects of ITOps or themes were dominant in each decade or not. Table 4 above shows the breakdown per decade.

## 4 Assessment of the Literature

### 4.1 Disproportionate Focus on System/Software Maintenance

The analysis presented in Table 4 above shows that across the four decades between 1980 and 2020, ITOps articles that were published in the AIS basket had a total of eighteen articles, representing 62.1% that focused on maintenance. Four articles, representing 13.79% focused on Knowledge/Skillsets Management. Three articles, representing 10.34% focused on Service Management. One article each, representing 3.45% focused on Change/Risk Management, Process Management, and Tools Management. No articles were published in three ITOps aspects, notably Configuration Management, Incident Management and Customer Support.

### 4.2 Lack of Contemporary View of IT Operations

The analysis revealed that most of ITOps literature dates back to the 1980s and 1990s where IT systems were more simplistic, compared to today's complex and powerful IT systems and infrastructures. This pattern is evident across the last four decades. The 1990s witnessed the highest level of interest in ITOps with 11 articles, representing 37.93% followed by the 1980s and 2000s with 7 articles, representing 24.14 each. The 2010s came last with 4 articles, representing 13.79%. This trend is surprising considering that the vast majority of the innovations and advancements behind today's complex IT systems occurred in the last decade, with a corresponding increase in ITOps management software, budgets and demands on ITOps professionals (Gartner 2020). The 1980s and 1990s were characterised by much simpler/isolated systems. However, from the 2000s, complex and integrated systems like ERP, CRM, mobile computing, virtualisation, digital platforms, cloud computing and other modern technologies emerged that changed the IT landscape (Gartner 2020).

### 4.3 Decline of IT Operations in Top IS Journals

Lastly, our analysis shows that each of the four decades between 1980 and 2020 witnessed significant interest in System Maintenance. This is followed by Knowledge and Skillsets Management, which had publications in three decades, except the 2010s. This is followed by 'Service Management' which had publications in two decades, the 1990s and 2010s. In terms of total breakdown, as per Table 5 below, the 1980s saw publications in four ITOps aspects (System Maintenance, Process Management, Tools Management, and Knowledge/Skillsets Management). The 1990s also saw publications in four ITOps aspects (System Maintenance, Service Management, System Audit, and Knowledge/Skillsets Management). The 2000s saw publications in three ITOps aspects (System Maintenance, Change/Risk Management, and Knowledge and Skillsets Management). Finally, the 2010s saw publications in two ITOps aspects (System Maintenance and Service Management). This pattern again points to a decline in ITOps research, particularly in recent times where there is a greater need for such researches.

**Table 5.** IT operations literature total breakdown (between 1980–2020)

| IT Ops Aspects | 1980s (40 yrs) | 1990s (30 yrs) | 2000s (20 yrs) | 2010s (10 yrs) | Percent |
|---|---|---|---|---|---|
| 1. System Maintenance | 4 | 6 | 5 | 3 | 18 (62.1%) |
| 2. Config Management | | | | | 0% |
| 3. Change/Risk Mgmt | | | 1 | | 1 (3.5%) |
| 4. Incident Management | | | | | 0% |
| 5. Service Management | | 2 | | 1 | 3 (10.3%) |
| 6. Process Management | 1 | | | | 1 (3.5%) |
| 7. Customer Support | | | | | 0% |
| 8. System Audit | | 1 | | | 1 (3.5%) |
| 9. Tools Management | 1 | | | | 1 (3.5%) |
| 10. Knowledge/Skillsets Management | 1 | 2 | 1 | | 4 (13.8%) |
| **Percent** | **7 papers (24.1%)** | **11 papers (37.9%)** | **7 papers (24.1%)** | **4 papers (13.8)** | **29 (100%)** |

# 5 Discussion: Assessing the Status of Current Research and Agenda for the Future

The previous section showed that there is an uneven pattern in ITOps research, where some aspects are overlooked. In this section, we discuss the possible reasons and propose directions for future research.

## 5.1 Wider Perspective on IT Operations

The literature review revealed that research on ITOps disproportionately focused on software maintenance. One reason for this is that IS adoption research often considered IS development and use, with little attention to IT operations. Also, in practice, most organisations do not acknowledge operational costs when deciding on new systems (Berghout et al. 2011). Further, outsourcing and cloud computing have shifted some aspects of ITOps to third parties.

Since ITOps is at the forefront of IT adoption and use, it is a fertile ground for taking IT seriously and opening its blackbox (Orlikowski and Iacono 2001). In this regard, the context of ITOps provides a unique opportunity for sociotechnical and sociomaterial researches to explore the interactions between human and non-human actors from various perspectives. This could be achieved by targeting configuration management, incident management and customer support.

The scope of ITOps literature could also be widened to include aspects like IT incident management. This is needed because the majority of IT budget/resources in IT organisations are dedicated to ITOps activities (Goldstein et al. 2011). Also, the relationship between vendors, contractors and internal operational teams is yet to be examined thoroughly although, many organisations adopt smart IT systems and analytic tools developed by vendors to manage their complex IT systems and infrastructures.

## 5.2 IT Operations and Adoption of Intelligent Technologies

ITOps is undergoing major transformations, with the adoption of novel/predictive data analytics approaches and fast-speed IoT connected devices that are enabled by AI. This presents a high level of social and technological complexity worthy of examination, despite difficulties with site access. From our experience, access to such operational environments is often restricted by organisations owing to their sensitive nature and contractual agreements with clients and vendors who have economic interests in protecting their innovations. Similarly, they are keen to ensure that system flaws are not publicised, to give them a chance to address them without the prying eyes of outsiders.

Nonetheless, it is important for IS research to pay attention to ITOps because it is an important field where the majority of IT professionals work. Further, considering that ITOps environments are replete with advance technologies, it is difficult to completely separate social and technological actors since IT is ubiquitous and manifestly act in ways that make a difference in the world. This should allow IS researchers to readily explore the advanced IT that pervade organisations (Orlikowski and Iacono 2001).

Further, since ITOps environments are at the forefront of IT innovation, adoption and use, they provide an ideal context for IS innovation researchers to broaden their scope beyond start-ups. By also exploring established IT organisations that are at the forefront of large-scale IT development, to for instance explicate how new technologies are integrated with existing technologies or how organisations transition from one technology to another. Such insights would help to shed more light on why some IT adoption initiatives are successful, whilst others fail. This would also help to shift the focus of IT adoption research to the long-term, rather than just the short term as is typical when such researches focus on the development phase, which is relatively short.

### 5.3 Theorisation on IT Operations

The interactions that unfold between human and non-human actors and their respective agencies, and how these collaborate within AI, IoT and sensor-based systems that are currently on the rise had led to the phenomenon of ‘IT for IT management’. Whereby one form of IT manages another autonomously as is typical in IT operations, where intelligent IT sensors and tools routinely scan the health of interconnected IT systems to detect and report emerging signs of failure or performance abnormality. This informs other smart IT tools to intervene or alert ITOps engineers where necessary.

This and other similar trends that are facilitated by smart IT deserves research attention to help advance IS theorization, regarding the role of intelligent IT systems in organising. Examining ITOps in such contexts also opens up opportunities for revisiting our understanding of concepts like **‘organising’** and **‘work’** and who performs them and how or for what purposes (Elbanna et al. 2020).

### 5.4 Complex/Multidisciplinary Knowledge Ecosystem

ITOps is rich in both organisational processes and technical knowledge that emanates from diverse disciplines and technological ecosystems. This makes ITOps “knowledge ecosystem” dynamic whilst also traversing different boundaries and knowledge domains (Ramakrishnan et al. 2018), as depicted in Fig. 2 below. This includes both open-source and proprietary knowledge that are tied to various network protocols, vendor products and software applications. From this perspective, the knowledge base of ITOps departments is distributive. Further, with every new product release or customer provisioning comes new configurations that require existing knowledge to be updated to effectively integrate new configurations (Abeck and Mayerl 1999).

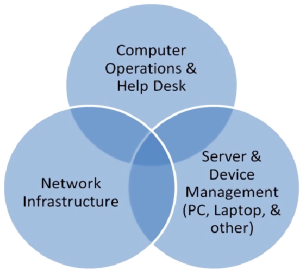


**Fig. 2.** ITOps knowledge domains (From: (Hetvik 2014))

Today, the complexity and dynamism of IT systems and infrastructures imposes additional demands, in terms of the management of ITOps skillset and knowledge base. This calls for further research to unearth how organisations manage their diverse and decentralised knowledge ecosystems. This is an important endeavour because whilst there is extensive literature on knowledge management (Hawk et al. 2009; Gupta et al. 2009; Orlikowski 2006; Suchman 2000), these mainly assume that organisations have full and centralized control over their operational knowledge.

However, the complexity of modern IT systems partly stems from the fact that often different vendors and third-party solution providers with proprietary knowledge, inter-disciplinary teams with domain knowledge, clients and regulatory agencies all need to collaborate to deploy and operate these systems. From this perspective, the associated knowledge is very distributed. This opens up opportunities for exploring distributed work performance from a modern perspective. Future researches could also examine the associated complex and multidisciplinary 'knowledge ecosystem' to for instance address how reliable performance is attained within such complex organising contexts.

Also, whilst the traditional notion of teams generally refers to a collection of people, in the context of ITOps, this understanding seems limited because non-human actors also participant in the performance of operational tasks. From this perspective, the constitution of teams in ITOps departs from the typical/human-centred view. This presents opportunities to revisit the notion of teams from the perspective of modern organisations that are equally reliant on intelligent technologies.

## 6 Conclusion

IT operations is a critical function in modern organisations. Following a review of IT operations literature in eight top IS journals, the current paper revealed three main findings, notably the disproportionate focus on System/Software Maintenance, lack of contemporary view of ITOps, and a decline of ITOps in Top IS Journals. The paper proposes four main future research directions that would help enrich ITOps literature and make it more relevant to contemporary IS organisations.

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