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Navigating digital transformation through an information quality strategy: Evidence from a military organisation

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Abstract

The use of digital technologies for extracting information from various data sources can help organisations to reduce uncertainty and improve decision-making. The increasing availability in volume, velocity, and variety of data, however, can give rise to significant risks and challenges in ensuring a high level of information quality (IQ). Pre-digital organisations can be particularly susceptive to such challenges due to their limited experience with digital technologies and IQ governance. We adopt a theory-infused interventionist research approach to assist a pre-digital multinational military organisation in navigating its digital transformation (DT) by focusing on IQ. We design and implement an IQ strategy (IQS) by drawing upon organisational information processing theory and examining how the level of IQ can affect the balance between information processing requirements and capacity. We demonstrate that an IQS that incorporates both technological, as well as IQ governance solutions, can support organisations in setting the scope of their DT, decreasing employees' resistance to change, and

increasing their satisfaction, while concurrently improving organisational efficiency. Our work stresses the importance of IQ in the digital era and delineates how pre-digital organisations can navigate DT by strategically addressing IQ.

KEYWORDS
canonical action research, digital transformation, information quality governance, information quality strategy, organisational information processing theory

1 | INTRODUCTION

Information is vital for decision-making and, consequently, organisations increasingly aim to collect and process large amounts of data from various sources by adopting novel digital technologies (e.g., Bharadwaj et al., 2013; Günther et al., 2017). Processing large amounts of data can, in theory, result in valuable outcomes; in practice, however, there are various relevant risks associated with data governance. For instance, data of high volume, velocity, and variety is characterised by its incomplete and unstructured nature, posing threats to the level of information quality (IQ)[1] (Clarke, 2016). The potential that data and information encapsulate for organisations, however, can be fully unleashed only when these are of high quality (e.g., Hazen et al., 2014; Wahyudi et al., 2018). IQ, thus, becomes an increasingly important element of data governance (e.g., Khatri & Brown, 2010), with significant implications for organisations and their stakeholders, affecting inter alia their ability to respond to crises (Alamsyah & Zhu, 2022), purchasing intentions (Wu et al., 2021), and employee satisfaction (Haug et al., 2011).

Although organisations, in general, are becoming increasingly aware of their IQ issues (Madnick et al., 2009), their solutions often seem to not address how information, organisational processes, and information systems (IS) interact (Katz-Haas & Lee, 2005) and the literature provides few insights on how to ensure a high level of IQ (Işık et al., 2013). Novel digital technologies and techniques (e.g., artificial intelligence), however, may hold great potential for improving the level of IQ (e.g., Côrte-Real et al., 2020; Janssen et al., 2020; Taleb et al., 2021), and organisations increasingly engage in digital transformation (DT) endeavours to gain access to more and higher quality information (Chanias et al., 2019; Vial, 2019).

Such endeavours, however, primarily lead to failure due to their complexity (De la Boutetière et al., 2018). Especially pre-digital organisations that have been successful in the past without relying on digital technologies (Chanias et al., 2019; Sebastian et al., 2017) may experience additional challenges in adopting combinations of technologies that could radically change the way they operate. While such pre-digital organisations could benefit significantly from improved access to high-quality information, they tend to have limited experience with processing (large amounts of) data and are rarely capable of readily incorporating novel and advanced technologies. It, thus, becomes timely and topical for pre-digital organisations to acquire insights on how they can navigate their DT to fully exploit the opportunities of increased access to data and information.

To address that lacuna, we conduct canonical action research (CAR) at a multinational military organisation in Europe (henceforth AirTrans, a pseudonym) that had reported challenges related to its DT endeavour over a period of two years. As a pre-digital organisation, AirTrans had been successful in its air transport operations

[1]Consistent with prior research (e.g., Knight & Burn, 2005), we use the terms *data quality* and *information quality* interchangeably and refer to both as information quality (IQ). Following organisational information processing theory (OIPT), we consider IQ issues as those related to collecting data, transforming data into information, and understanding, storing, and exchanging that information. This is also supported by our data and analysis, since the interviewees of our study referred to both data quality and IQ issues as IQ ones, mentioning that in their opinion the term better encompassed all the data and information challenges they were experiencing in the focal organisation.

without relying on digital technologies, yet experienced increasing pressures to engage in DT. We thoroughly diagnosed the challenges that AirTrans faced and implemented, as well as evaluated an IQ strategy (IQS) in collaboration with its top management, which allowed them to further navigate their DT. In doing so, we conducted 43 semi-structured interviews with 22 employees of AirTrans and analysed a total of 204 relevant organisational documents.

Our diagnosis revealed that improving the level of IQ was an implicit driver for the DT of AirTrans, while the poor IQ *status quo* was a barrier to its effective execution. AirTrans had been primarily focused on implementing digital technologies, paying scant attention to governance solutions related to such technologies. To understand how we could improve the situation at AirTrans, we adopted the theoretical lens of organisational information processing theory (OIPT) (Galbraith, 1973), stressing the importance of realising a fit between information processing requirements (IPR) and information processing capacity (IPC), and acknowledging that increased amounts of information can reduce uncertainty and improve decision-making. Our analysis of the *status quo*, however, elucidates the crucial role that IQ plays in obtaining a fit between IPR and IPC. We then developed and implemented an IQS, through which we show that a focus on both technology and IQ governance has significant implications for organisational information processing (OIP), and for effectively navigating DT.

Our work brings forward novel insights and has timely and topical implications for both IS theory (Struijk et al., 2021) and practice (Davison, 2022). Concerning the former, we contribute to the research agenda on DT, as well as to OIPT, and elucidate the critical interrelationships amongst DT, IQ, and OIP. First, we extend traditional OIPT by examining the implications of *quality*, rather than quantity of information, for the fit between IPR and IPC. More specifically, we show that poor IQ can increase IPR, thereby influencing the fit between IPR and IPC, and hampering operations as well as processes. Such insights are especially valuable in the digital era, as data and information are vital for organisations, and increasing amounts of data and information from multiple sources can give rise to challenges in ensuring a high level of IQ (e.g., Abraham et al., 2019). Moreover, the absence of sophisticated IS and existing IQ issues, make it especially complex for pre-digital organisations to improve their level of IQ and adopt digital technologies. Second, we go beyond the familiar sources of DT barriers cited in the IS literature (Vial, 2019), and show that poor IQ can represent a key barrier to the DT of pre-digital organisations. As illustrated by our findings, DT might not yield its desired outcomes if organisations primarily focus on technology, neglecting solutions and activities focused on governing IQ. The extant literature on DT, however, has largely overlooked the importance of data governance and, more specifically, the importance of IQ during such endeavours. Finally, we contribute to the broader DT research agenda by establishing that pre-digital organisations can set the scope for their DT by designing and implementing an IQS consisting of targeted initiatives. By balancing both technological as well as IQ governance solutions, organisations can navigate their DT and improve the balance between IPR and IPC accordingly. By adopting a theory-infused interventionist research perspective, we largely illustrate the practical implications of our work and assist pre-digital organisations in better navigating their DT by strategically addressing IQ.

The rest of the paper is organised as follows. In the next section, we discuss the background of our study on IQ and DT, before proceeding with a detailed description of the theory, research approach, as well as the setting of our study. The penultimate section presents our findings, while we conclude the paper with a discussion of our work and its implications for both theory and practice, delineating an agenda for future research on the topic.

2 | BACKGROUND

2.1 | Data governance and information quality

Data governance is concerned with data accountability and decision rights (e.g., Khatri & Brown, 2010), approaching data and information as key strategic assets (e.g., Abraham et al., 2019). Organisations, thus, need to have adequate

data governance solutions in place for ensuring the quality of data and information (Khatri & Brown, 2010), and, as such, IQ becomes one of the key data governance elements. IQ-focused data governance, thus, is concerned with improving IQ management and monitoring (e.g., Malik, 2013; Weber et al., 2009).

IQ is a multidimensional construct, often defined as information that is fit for use by information consumers (Wang & Strong, 1996). In line with the literature (Madnick et al., 2009), we approach IQ from a unified perspective, looking at both data as well as information issues, and dimensions. The literature identifies various IQ dimensions, some of which have been adopted widely, while others have received less attention. Such dimensions can help to generate a better understanding of IQ-related issues (Fox et al., 1994). Whilst there is a lack of consensus regarding which set of IQ dimensions to apply, almost all relevant prior studies have used variations of *accuracy*, *completeness*, *consistency*, and *timeliness* (Sebastian-Coleman, 2012). In doing so, prior studies have demonstrated the link between IQ dimensions and organisational outcomes (e.g., Gharib et al., 2018; Wang et al., 1995). For instance, business processes rely on IQ, and information should be treated as a product for managing and improving processes (Wang et al., 1995) since poor IQ might threaten their effective execution (Gharib et al., 2018). Concurrently, IQ issues can lead to (i) mistrust on the tactical level, (ii) adverse effects on strategy-making on the strategic level, and (iii) stakeholder dissatisfaction and increased cost on the operational level (Redman, 1998).

Besides their direct implications for organisations, IQ and system quality (SQ) have been extensively linked to IS success (DeLone & McLean, 1992). In this study, we approach IQ not as the mere output of IS (DeLone & McLean, 1992), but as a broader concept that can address different types of information from various sources (e.g., fit for purpose). Whilst we acknowledge the significance of SQ for organisational outcomes, we adopt the notion of IQ since DT goes beyond mere information technology (IT) adoption and implementation (Kane et al., 2015). As IQ is influenced by both technical (e.g., the failure to integrate data from various sources) as well as organisational aspects (e.g., the lack of strategic IQ initiatives) (Madnick et al., 2009), it can better address changes to both technical and organisational properties during DT. We do, however, take system aspects into account, recognising that SQ can potentially influence the level of IQ (e.g., Xu et al., 2013) and that to address IQ issues can involve improving existing as well as adopting new IS.

To address and improve the level of IQ, organisations first need to evaluate their IQ *status quo*. The level of IQ can be evaluated from both subjective and objective perspectives. Objective IQ measures the extent to which information conforms to quality specifications and references (Ge & Helfert, 2013), while subjective IQ is concerned with the expectations of the collectors, custodians, and consumers of information (Ballou et al., 1998; Wang, 1998). Even if the information meets objective requirements, it can still be perceived as of poor quality due to delivery problems or differences in expectations (Price & Shanks, 2016). Many IQ assessment frameworks have been developed, which take either a subjective or objective perspective, focus on technical or organisational issues, and provide organisations with an understanding of their current IQ level. While there are various frameworks for assessing the level of IQ, there are limited instructions for how to subsequently improve it, providing limited actionable directions for organisations (Nielsen, 2017), leaving such a timely topic largely unexplored in the extant IS research agenda (Petter et al., 2013).

The information-intensive nature of organisations, however, requires a strategic approach to IQ to ensure that the appropriate information is available to the right people, at the right time, while preserving privacy and conforming to laws and regulations (Kerr et al., 2007). An IQS aims to address IQ-related issues and improve the level of IQ. Organisational responses to IQ-related issues, however, are not always successful, since such issues often involve accumulated, lengthy, and hidden processes, and signal root conditions that can lead to difficulties with using information (Lee et al., 2006). Initiatives for improving the level of IQ, therefore, must define a plan with the goals to be improved (Caballero et al., 2004), which can be described as a strategy for understanding the IQ *status quo* and how to improve its level for meeting the strategic goals of the focal organisation (Jugulum, 2014). The goal of an IQS, thus, is to reduce the misalignment between IQ and the organisational strategy. The alignment of IQ and organisational objectives can increase the synergy amongst the various functional units (Akter et al., 2016) and, consequently increase organisational efficiency (Sebastian-Coleman, 2012). In the context of IQ, Dravis (2004, p.28)

defines strategy as "a cluster of decisions centered on goals that determine what actions to take and how to apply resources". Without an IQS, organisations might suffer from an inability to integrate, poor performance and availability, little accountability, as well as the general feeling that things are out of control.

To realise the benefits of IT investments, thus, organisations need an understanding of their IQ, and assessing the IQ *status quo* is one of the most critical aspects of an IQS (e.g., Kerr et al., 2007; Sebastian-Coleman, 2012). Most of the existing IQ assessment frameworks include similar steps but use different activities and measurements. Assessing the level of IQ, however, largely depends on the context, and the existing frameworks do not have a universal fit with organisational requirements. With the gamut of possible requirements, organisations may be forced to select an existing framework, which may not be suitable for their needs, leading to undertaking unnecessary activities or omitting essential ones (Woodall et al., 2013). Developing an assessment framework tailored to the specific needs of an organisation is, thus, a better solution. We take these research perspectives further in our empirical work.

2.2 | Digital transformation of pre-digital organisations

Organisations in all industries are increasingly pressured to engage in DT for a gamut of different reasons, while mostly including initiatives aimed at collecting and analysing increasing amounts of data from various sources to improve their processes and operations (e.g., Dremel et al., 2017). DT can be defined as a process that "aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019, p. 121). Such a process requires significant changes in, inter alia, strategy making (Bharadwaj et al., 2013; Matt et al., 2015), organisational processes, culture (Karimi & Walter, 2015), and value creation paths (Vial, 2019). DT endeavours often relate to the implementation of applications related to social media, mobile, business analytics, cloud, and the internet of things (Sebastian et al., 2017), as well as novel digital technologies and techniques (e.g., artificial intelligence), which can significantly enhance collecting and processing information (Aben et al., 2021; Bharadwaj et al., 2013; Setia et al., 2013; Vial, 2019).

DT, thus, can enable organisations to significantly enhance their capacity of processing data of high volume, velocity, and variety (Li et al., 2021). Social media platforms, for instance, can be used to collect large amounts of data related to the preferences and opinions of consumers (e.g., Georgiadou et al., 2020), which can be then further exploited through advanced business analytics approaches (Angelopoulos et al., 2021; Kretschmer & Khashabi, 2020). Gleaning such insights into stakeholder demands as well as expectations is vital for navigating DT, and for understanding how organisations can pursue novel ways of creating value and enhancing their operations in the digital era. While such technologies, thus, offer great potential for improving the capacity of organisations to process information, the effects of poor IQ might be exacerbated by the increased reliance on digital technologies in our information-intensive and knowledge-based economy. As organisations have access to data of increasingly high volume, velocity, and variety, ensuring their quality becomes more complex and requires more attention (Abraham et al., 2019; Clarke, 2016). For instance, a high number of different data sources can make the monitoring of data provenance an increasingly complex and tedious process (Buneman et al., 2001).

Such challenges might be especially present in the context of pre-digital organisations, which have been operating successfully for many years without using digital technologies. Pre-digital organisations often belong to traditional industries and are now threatened by the rise of digital-native ones (Ross et al., 2016). While organisations in general experience extremely high levels of DT failure due to the complexity and comprehensiveness of actions they attempt to undertake (De la Boutetière et al., 2018; Singh & Hess, 2017), such levels might be higher for pre-digital organisations that lack the knowledge and experience to digitally transform (e.g., Bharadwaj et al., 2013; Sebastian et al., 2017; Siachou et al., 2021). DT represents ongoing structural changes that balance the exploitation of existing capabilities and the exploration of new ones (Sebastian et al., 2017). This means that pre-digital organisations need to not only understand their business needs, but also

their technological needs and how novel technologies work (Loonam et al., 2018). While they tend to have increased access to large volumes of data (Klievink et al., 2017), they experience challenges related to ensuring their level of IQ and establishing formal programmes (Nielsen et al., 2018). Such findings lead to arguments that pre-digital organisations may be unable to navigate their DT (Siachou et al., 2021). Pre-digital organisations, thus, face significant DT challenges, offering an opportunity for IS scholars to examine how such organisations can navigate their DT effectively and efficiently.

3 | METHODOLOGY AND THEORETICAL FRAMEWORK

3.1 | Research context

We conducted our study at a multinational military organisation responsible for the air transport missions of participating Air Forces. The aim of AirTrans is to combine resources and assets from the participating Air Forces and utilise them in such a way that improves the efficiency and effectiveness of air transport missions. AirTrans had been successful without relying on any advanced digital technologies and, therefore, can be classified as a pre-digital organisation (Chanias et al., 2019). Besides its limited experience with digital technologies, AirTrans is subject to various stakeholders, cultures, security requirements, and (inter)national laws. Apart from the participating nations, the relevant stakeholders also include, inter alia, other multinational military organisations, broker agencies, and hospitals. Employees working at the headquarters (HQ) of AirTrans come from participating nations and have a variety of cultural, educational, and functional backgrounds, which makes the harmonisation of rules, processing, and operational procedures a challenge. Another significant challenge is related to security and regulations, as AirTrans must deal with both national, supra-national, and international laws.

Moreover, the IT architecture of AirTrans is largely dependent on both the host and the participating nations. As a result, AirTrans must deal with significant environmental turbulence, resulting from the collaboration between the participating nations, as well as political, social, and crisis events. To improve operational efficiency and continuity, the top management of AirTrans officially indicated the need for DT in 2017, after experiencing increasing pressures from stakeholders to incorporate new digital technologies. AirTrans needed a new, modular IT infrastructure with high fault tolerance, supported by redundant, highly available services. Such an infrastructure had to be complemented by certified gateways, allowing secure information exchange from various (mobile) locations. Concurrently, the top management of AirTrans desired to incorporate mobile, cloud, and analytical tools to enhance its operations.

AirTrans, however, failed in its DT attempts and reached out for support in assessing the reasons behind such failure, as well as in delineating a path to successfully navigate its DT. After an introductory meeting and some trial work, we were allowed access to employees, organisational documents (e.g., meeting minutes, strategic directives, standard operating procedures) of the past ten years, and necessary resources. Our first engagements with AirTrans revealed that it mainly initiated the DT endeavour to resolve issues they were experiencing, which were related to the level of IQ. As decisions made in a military context can have far-reaching consequences, the exploitation of high-quality data and information becomes critical. Moreover, military organisations can be especially susceptible, since they face more prominent issues related to preparing infrastructure, changing mindsets, sensitivity, and security (Haridas, 2015). While digital technologies can play a crucial role in increasing the level of IQ, the use of new technologies can concurrently significantly increase the information-related vulnerability of such organisations. Although military organisations increasingly engage in DT (Heltberg, 2021), increased reliance on technical systems for processing information might make failures significantly more disruptive (Alberts, 2002).

3.2 | Research method

Our preliminary meetings with the top management of AirTrans and its Communication and IS (CIS) branch pointed us towards action research (AR) as a viable approach for investigating and addressing their problems. Compared to a case study, AR involves an intervention in which the research team is directly involved in the change process. As the DT endeavour of AirTrans was extremely challenging but the top management was determined to continue with it, the situation represented a unique opportunity to explore how organisations can navigate DT in practice. While a case study would only enable us to examine actions from the past, AR further enabled us to examine and evaluate how interventions would contribute to navigating DT. Prescriptions of how organisations can successfully navigate DT in practice are seldom encountered in the literature yet are sorely needed by IS scholars and practitioners.

We have specifically chosen to guide our study based on the theory-infused interventionist approach of CAR since it requires researchers both to investigate as well as to change an organisational situation while emphasising the role of theory for guiding the research project and for providing relevant and efficient outputs. We focused on the DT and IQ situation at AirTrans, engaging in change through interventions, thereby generating both practical and scholarly knowledge (Davison et al., 2012). Compared to other AR approaches (e.g., Avison et al., 1999; Davison et al., 2021), CAR is characterised by its iterative, rigorous, process-oriented nature in which collaboration with the case organisation is key (Susman & Evered, 1978), covering five major phases (Davison et al., 2004): (i) diagnosis, (ii) action planning, (iii) intervention, (iv) evaluation and (v) reflection. Moreover, CAR offers a comprehensive set of principles and criteria for ensuring the relevance and rigour of a research project (Davison et al., 2004; Davison et al., 2012). CAR adheres to a set of five principles, namely (i) the researcher-client agreement principle, (ii) the cyclical process model principle, (iii) the theory principle, (iv) the change through action principle, and (v) the learning through reflection principle (Davison et al., 2004). To assess the quality of our study, a comparison was made with these principles together with the project champions, namely, The Chief Operations Officer and the Senior Information Manager at AirTrans. We theorise and contextualise the five cyclical phases of CAR in our research, and demonstrate them visually in Figure 1, with further explanations in the following sections.

During diagnosis (phase i), we assessed the environment independently and identified a focal theory for the action plan that followed (Davison et al., 2012). The overall implementation consisted of action planning (phase ii), and intervention (phase iii) in the form of the development and implementation of an IQS. Action planning is the process of specifying actions that can improve the problem situation (Lindgren et al., 2004). Afterwards, the identified actions were applied during implementation. The proposed actions were designed to improve the identified problems and causes, and the team of researchers must be able to explain these planned actions (Davison et al., 2004). The IQS intervention was developed based on the IQ assessment and insights from the literature (action planning) and implemented on-site in collaboration with AirTrans. The last two phases were aimed at measuring the result of the implemented actions and determining the success and clarity of the DT directions (Davison et al., 2012). The evaluation phase (phase iv) involves measuring the result of the implemented actions and determining their success. In collaboration with the top management, we determined if the intended effects of the solution were realised (phase v), and critically questioned whether the undertaken actions could be identified as the only cause of success (Baskerville, 1997). We evaluated the implemented actions, and reflected upon them, while AirTrans can repeat this phase to evaluate whether the actions have been implemented effectively by undertaking another CAR cycle in the scope of the DT.

3.3 | Instrumental theory

CAR emphasises the role of theory in guiding the research project and in providing relevant and efficient outputs. In doing so, a focal theory is introduced to generate change and guide the research project, while instrumental theories

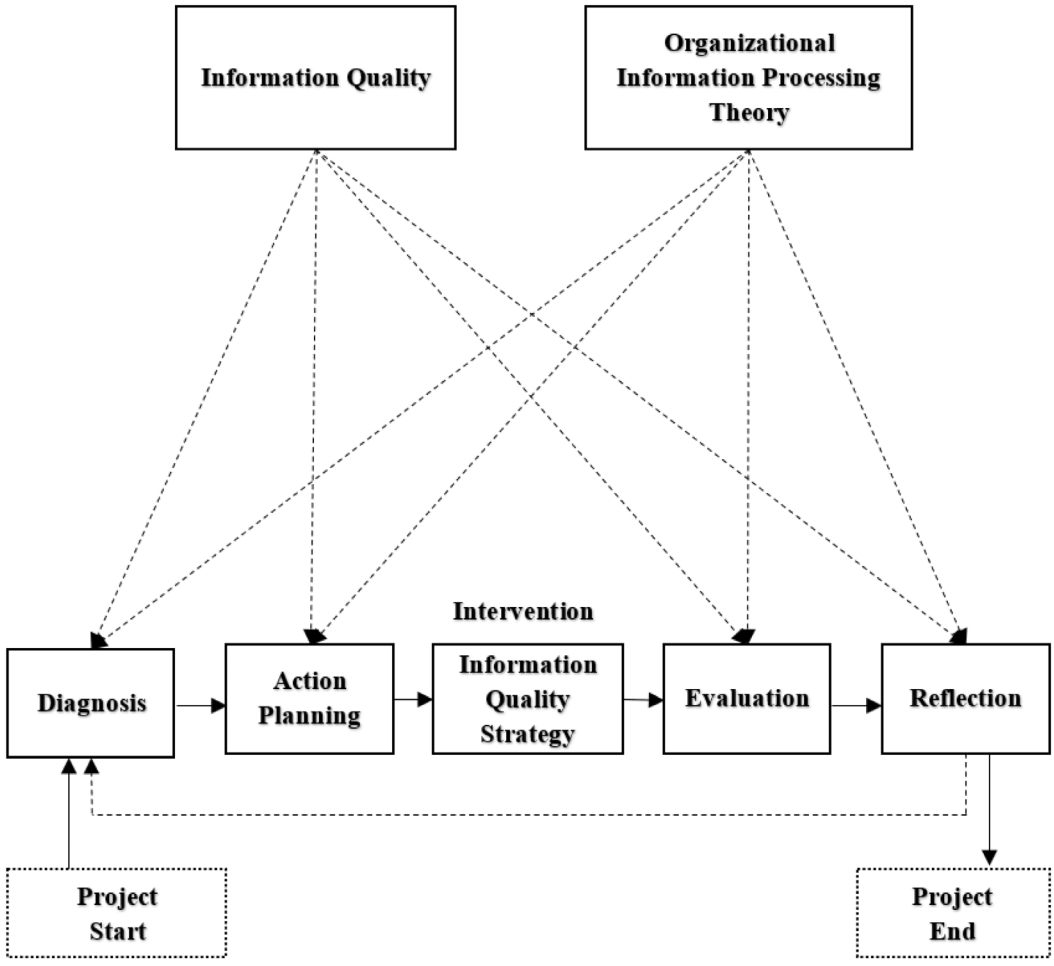


FIGURE 1 Canonical action research (CAR) process (adapted from Davison et al., 2012)

are used to establish the focal theory as well as to facilitate the various CAR phases (Davison et al., 2012). As an instrumental theory, we adopted the hybrid approach of Woodall et al. (2013), which presents guidelines for developing an IQ assessment framework tailored to the requirements of the focal organisation. The first step is to determine the goal of the assessment, which can vary depending on the intentions of the organisation. Afterwards, organisation-specific requirements related to the IQ assessment must be identified. To ensure the relevance of the requirements, it is useful to check that each requirement is induced from the identified goals (Woodall et al., 2013). The next step focuses on selecting relevant activities associated with the level of IQ, where a distinction is made between critical activities and optional ones. Hereafter, the activities that need to be included in the assessment for a specific organisation can be configured by arranging them in a sensible order and incorporating any activity dependencies (ibid). Thus, based on the identified activities that are important for an organisation, an approach towards assessing IQ can be developed.

A critical step of our assessment was to measure the IQ *status quo*. We focused on subjective IQ, as perception is a key indicator of the level of IQ in practice since it represents an actual use-based evaluation (Price et al., 2008). To evaluate the IQ *status quo*, we also used as instrumental theory the widely accepted subjective measurement approach established by Lee et al. (2002), which measures the level of IQ through various dimensions. We further reviewed the literature on IQ to identify more relevant IQ dimensions and included questions about these

TABLE 1 Overview of information quality (IQ) dimensions

IQ dimension	Definition	References
Accessibility	The extent to which information is available, or easily and quickly retrievable. It is concerned with the speed and ease of locating and obtaining data or information relative to an activity	Pipino et al. (2002) Stvilia et al. (2007)
Accuracy	The extent to which information is correct, reliable, and certified. It is a measure of whether the value of information is correct and reflects the real world	Wang and Strong (1996) Jugulum (2014)
Appropriate amount	The extent to which the volume of information is appropriate for the task at hand. When too much or too little information is available, organisational decision-making becomes harder	Pipino et al. (2002) Samitsch (2014)
Believability	The extent to which information is regarded as correct, true, real, and credible. Users' knowledge, experience, and uncertainty influence the level of believability	Pipino et al. (2002) Fisher et al. (2012)
Completeness	The extent to which core information elements are present for completing a specific business process. It is often connected to the ability of an IS to represent every meaningful state of the real world	Wand and Wang (1996) Jugulum (2014)
Concise representation	The extent to which information is compactly represented. In other words, information should be well formatted on the one hand and clear and complete on the other hand	Pipino et al. (2002) Zaveri et al. (2016)
Consistency	The extent to which the logical relationship between correlated information is correct and complete. Consistency can be regarded as the absence of variety or change or the extent to which information is presented in the same format	Pipino et al. (2002) Sebastian-Coleman (2012) Cai and Zhu (2015)
Ease of understanding	The extent to which information is clear without ambiguity and easily comprehended	Wang and Strong (1996)
Interpretability	The extent to which users understand information and perceive information to be in appropriate languages, symbols, and units	Pipino et al. (2002)
Objectivity	The extent to which information is unbiased, unprejudiced, and impartial	Wang and Strong (1996)
Relevancy	The extent to which information is applicable or appropriate for the required task	Tee et al. (2007)
Reputation	The extent to which information is highly regarded in terms of its source or content	Pipino et al. (2002)
Security	The extent to which access to information can be restricted and, hence, protected against its illegal alteration and misuse	Zaveri et al. (2016)
Timeliness	The extent to which information represents reality from the required point in time. In other words, it refers to the extent to which information is up to date for the required task	English (1999) Wand and Wang (1996)

dimensions in the interview protocol. Our final IQ assessment framework included 14 dimensions as indicated in prior IQ studies (e.g., Stvilia et al., 2007; Wang & Strong, 1996), namely: timeliness, completeness, consistency, reputation, relevancy, ease of understanding, conciseness, accessibility, security, accuracy, objectivity, believability, interpretability, and appropriate amount (see Table 1).

3.4 | Focal theory

Following the principles of CAR, we incorporated a focal theory to understand the *status quo* at AirTrans and to guide us in developing as well as implementing an appropriate solution. Consequently, we looked for a theory that could explain the operational efficiency and effectiveness of organisations by primarily looking at the role of information. The basic premise of OIPT is that resolving uncertainty is the key task of organisations, where uncertainty is caused by a lack of information about, inter alia, tasks and the environment, and hampers the operations of organisations (Galbraith, 1974). Consequently, organisations can reduce such uncertainty by balancing their IPR and IPC. We used this conceptualization to understand the *status quo* between IPR and IPC, how the level of IQ affects the balance between IPR and IPC, and how we could design and implement an IQS to optimise the balance between IPR and IPC.

Information processing has always been a key success factor for organisations (Galbraith, 1973), and consequently, organisations are constantly trying to exploit the advantage of having access to real-time information by implementing novel, digital technologies that support them in doing so (Srinivasan & Swink, 2018). In terms of the broader information management (IM) practices of organisations, information processing is arguably the most critical valuation point, as it determines whether the available information meets the needs of the organisation (Kettinger & Marchand, 2011). It includes activities focused on collecting data, transforming it into information, and ultimately communicating and storing it. While such activities can take place at both individual and organisational levels, the latter is more than the sum of the former, since individual diversity, information asymmetry, and disagreements can make OIP more challenging (e.g., Daft & Lengel, 1986). If organisations manage to balance their IPC and IPR, however, they can significantly enhance the effectiveness of their processes.

IPR refers to the information that is necessary to perform tasks, while IPC refers to the ability to collect data, transform it into information, and store it in such a way that it is accessible to those who need it. Hence, the extant literature has primarily defined IPR in terms of the quantity of information, referring to it as the "necessary *amount* [emphasis added] of information required to satisfy decision-making for a particular set of objectives" (Zhu et al., 2018, p. 49). IPR, thus, represents the level of uncertainty, which can be defined as the difference between the information required and possessed (Galbraith, 1973), and can have various causes, such as the complexity of the tasks to be performed or exogenous events such as crises. Moreover, IPR can vary amongst organisations and subunits (Gattiker & Goodhue, 2004), and can have different underlying root causes, such as task ambiguity, market changes, the complexity of organisational activities, and technological changes. Thus, the more uncertainty organisations face, the more information they need to process to deal with such uncertainty. As such, one of the main objectives of organisations is to deal with their changing IPC needs, which result from external uncertainties and internal complexities (Egelhoff, 1991).

Prior studies have identified various means for bringing balance between IPC and IPR. Different modes of coordination can be exploited by organisations to deal with different levels of uncertainty and IPR. For example, standard operating procedures are more effective when uncertainty is low, while IS can be especially beneficial when uncertainty is higher (Galbraith, 1974). To deal with the uncertainty associated with customers and suppliers, organisations can increase their IPC by investing in vertical IS (Srinivasan & Swink, 2015). One assumption here is that increasing information availability will improve organisational decision-making. To summarise, OIPT posits that activities should either try to enhance IPC or lower IPR, reducing their gap and enhancing organisational decision-making (Srinivasan & Swink, 2018).

Although we were pointed to the relevance of IQ during DT and the usefulness of OIPT during our data collection, prior studies have already loosely pointed to the importance of, and links between, the different concepts included in our study. During our study, we reviewed the literature again to see what relationships had been proposed before, and how our findings ultimately contributed to those streams of the literature. We mapped the core elements of our study and their proposed relationships (Watson & Webster, 2020; Webster & Watson, 2002), as

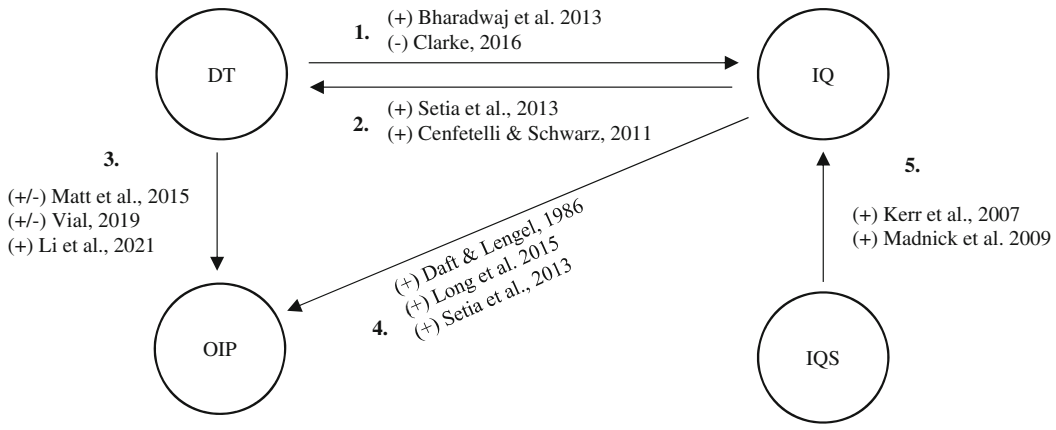


FIGURE 2 Map of concepts in the literature and their relationships. The (+) / (−) signs indicate whether the existing literature has pointed to a negative or positive relationship between the different elements. We briefly comment on these relationships below: (1) The literature points to two opposing effects of DT on IQ: (i) new technologies and processes related to DT can increase the quality of data and information, and (ii) huge amounts of data and information present new risks with regard to ensuring quality. (2) High-level IQ from the design of digital technologies can result in localised capabilities and improved customer service, while poor IQ has been linked to reduced technology usage. Hence, although focusing primarily on the technology aspect of DT, higher levels of IQ seem to be beneficial for DT. (3) We induce two different effects of DT on organisational information processing, namely i) that the implementation of digital technologies can increase information processing capacity and ii) that DT leads to high levels of internal and external uncertainty (and, hence, higher levels of IPR). (4) Higher levels of IQ facilitate the effective processing of information and the richness of information decreases uncertainty. (5) By implementing an IQS, organisations can manage and improve their IQ

TABLE 2 Overview of archival data

Source year	Strategic directives	Top management minutes	Middle management minutes	Total
2010	1	0	5	6
2011	1	5	24	30
2012	1	4	16	21
2013	1	3	24	28
2014	1	2	18	21
2015	0	4	16	20
2016	1	1	10	12
2017	0	2	10	12
2018	1	2	22	25
2019	1	4	24	29
Total/Source	8	27	169	204

presented in Figure 2, where we include illustrative examples of prior studies that point towards a relationship and provide further explanations of such relationships below the figure.

3.5 | Data collection and analysis

Our data collection was focused on available organisational archival data as well as interviews with employees of Air-Trans. The archival data comprised top and middle management meeting minutes, as well as strategic directives between 2010–2019, resulting in 204 documents (see Table 2). During the diagnostic phase, we reviewed and coded the archival data, specifically focusing on DT and IQ, to identify related themes. When the relevance of OIPT became clear, we went through the data again to further identify missed themes related to IPR or IPC. We also conducted three rounds of interviews, two during the diagnostic phase, and one during the evaluation phase, resulting in 43 semi-structured interviews over a period of six months in 2019, with 22 employees from various organisational levels and divisions.

TABLE 3 Interview participants' details (to preserve the anonymity of participants, we have generalised their exact function with comparable civil organisational functions).

Function	Position in the chain of command	Nationality	Code	Round
Chief Operations Officer	High	A	BGG-1	1,2,3
Director of Policy	High	B	CI-1	1,2,3
Deputy Director of Policy	High	C	CF-1	1
Director of Operations	High	D	CB-1	1,2,3
Director of Support	High	E	CD-1	1,2,3
Senior Information Manager	Medium	E	LCD-1	1,2,3
Executive Secretary	Low	D	CIVB-1	2,3
Head of Quality Management	Medium	C	LCF-1	2,3
Head of Training	Medium	C	LCF-2	2,3
Head of ICT Helpdesk	Low	C	ACF-1	2
Head of Data Analytics	Medium	B	LCI-1	2
Legal Affairs	Medium	E	LCD-2	2,3
Quality Management Assistant	Low	A	CG-1	2,3
Operations Desks	Medium	A	LCG-1	2
Head of Medical Support	Medium	A	CDG-1	2,3
Head of ICT	Low	A	CG-2	2,3
Senior Technician	Low	A	WOG-1	2
Head of Finance (predecessor)	Medium	E	MD-1a	2
Head of Finance (successor)	Medium	E	MD-1b	3
Head of Operations Desk	Medium	A	CG-3	2
Head of Security	Medium	E	MD-2	2,3
Medical Support	Medium	F	LCDS-1	2
HR Management	Medium	D	LCB-1	2,3
Logistic Support	Medium	F	LCS-1	2

We followed a purposive sampling approach to select the most relevant participants for our interviews, both at the strategy as well as operational levels, from different backgrounds, with different functions and different ranks, thereby increasing the validity of our findings (Thornhill et al., 2009). The function, rank, and nationality of the interviewees in our study, which were all based at the HQ of AirTrans, are presented in Table 3. We incorporated semi-structured interview protocols, enabling us to follow a predetermined list of questions, allowing for follow-up ones, and offering the opportunity to clarify difficulties as well as to elaborate on specific elements of the interview (Sekaran & Bougie, 2016).

The first interview round served as an initial diagnosis to identify challenges, objectives, and drivers of DT, followed by a second round for the IQ assessment, and a third one to evaluate the IQS, and validate our findings. After each interview round, the interviews were transcribed and coded. Our analysis started with individual interviewee experiences, and we then developed more abstract conceptual categories to explain and understand the data and identify patterns. The data was first divided into different overarching subjects, which we referred to as labels determined based on the themes that reoccurred during the interviews. Based on our initial conversations with the top management of AirTrans, we focused our interviews on the concepts of DT and IQ, while we identified the relevance of OIPT based on the interviews and the archival data. We further compared the interview data with the archival data on the standard operating procedures and business processes to thoroughly understand and evaluate the *status quo*. After our preliminary analysis, we carried out a detailed analysis of (i) the challenges of DT, (ii) the drivers and objectives of the DT endeavour, (iii) the IQ *status quo*, (iv) the factors that influence the level of IQ, and (v) the implications for OIP. We divided the data into overarching labels based on the recurrent themes and then assigned them to definition coding schemes. To visualise our findings, we created a data structure with first- and second-order concepts, as well as aggregate dimensions, as depicted in Appendix A.

The first interview round as well as preliminary meetings with the top management were open-ended and focused on DT, information flows, responsibilities, services, and processes of AirTrans. Our second and third interview rounds specifically incorporated the concept and dimensions of IQ to further explore the issues we identified in the first interview round. Although such a predetermined focus on specific concepts might lead to biased findings, we ensured that our semi-structured interviews allowed room for topics that the interviewees felt were important. To achieve this, all our interviews started with an open dialogue, which enabled the interviewees to share their experiences, rather than immediately putting the focus on IQ. The first author spent one year at the case organisation and conducted all the interviews, while the second and third authors also attended some of the meetings, and the last author participated in the reflection and theorization (Davison, 2020). Since all the interviews were recorded and transcribed, the first two authors reviewed the data and the emergent codes and themes, thereby increasing the validity of the findings we present in this study. In the following section, we describe the details and findings of this CAR according to the five-phase cycle.

4 | ACTION RESEARCH CYCLE

4.1 | Diagnostic phase

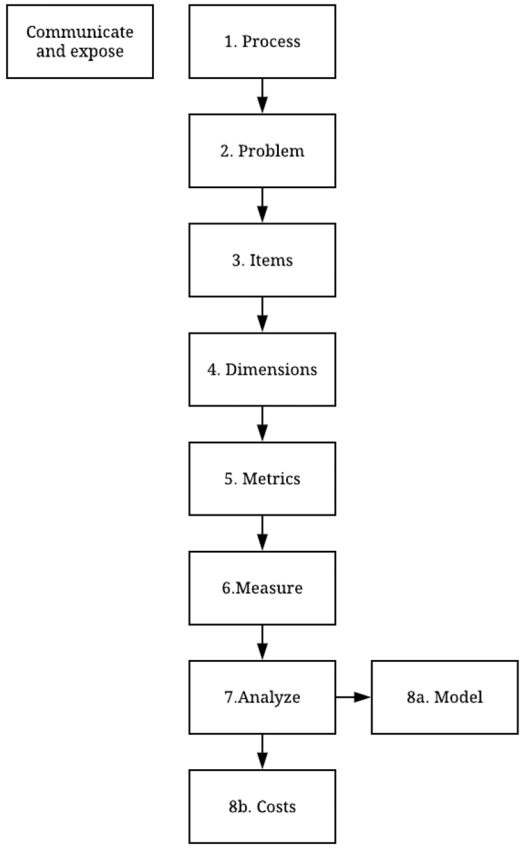
The diagnostic phase was officially initiated when the researcher-client agreement was finalised (see Appendix D). Before finalising the agreement, members of our research team had exploratory meetings with the top management and the CIS branch of AirTrans to (i) obtain an initial understanding of the problem they were facing, and (ii) identify the most suitable approach to explore and address the problem. These meetings revealed that AirTrans had been attempting to incorporate various digital technologies to transform its processes and operations. When we asked why they felt the need to engage in DT, we were first implicitly pointed towards problems related to IQ, as their DT attempts thus far had focused on solving IQ issues and improving information processing. We further explored the

successive DT challenges as well as the role of IQ in the first round of interviews, during the diagnostic phase of our study.

Our independent diagnosis aimed at providing a thorough understanding of the in situ organisational context and identifying a full set of problems and their causes, as AirTrans had already identified some problems during our exploratory meetings but could not make sense of their nature and exact causes. Hence, we conducted the first round of interviews with the top management of AirTrans to determine their intentions as well as the issues they experienced. The first round of interviews highlighted that IQ was the driver of DT. LCD-1 provided an example of why the command group had initiated the endeavour: "Asking for a standard operating procedure, people are very helpful, so within a day you have all of them on your table. However, I did it once and I asked seven people or eight people. And at the end of the line, I had five different versions on my table. That is why they are not happy, and I must agree, that is what has to change". CD-1 adds: "Especially the last step of actually doing something with the data leading to changes in the world and making things more efficient or effective, we miss that". The chief operations officer (BGG-1) further mentions one of the objectives hoped to be achieved by engaging in DT: "If we would be able to match different data so that we are not working with different data. Because we have different sources, and one is not knowing that the other one is working with different data on the same topic".

The interviews further revealed that the prior DT initiatives were subject to inertia, resistance to change, a lack of transparency, and the absence of a clear vision. Inertia is not only rooted in the daily operations of AirTrans, but also stems from the policies, regulations, and routines of the participating nations: "But especially in the old systems […] people are so stuck in their own little knothole that they just don't want to see that the world is changing" (LCD-1). Such inertia led employees to resist change, fearing that new technologies would make their work harder. By discussing with employees during our visits, and analysing the provided organisational documents, we unearthed that there was a lack of vision and transparency regarding their DT, as it was unclear for both the employees as well as the top management where the organisation was heading and what the benefit would be of incorporating digital technologies. Specifically, most interviewees felt that the information they had received regarding the DT of AirTrans was incomplete, hard to access, and not regularly updated. In other words, poor IQ was also experienced concerning the actual DT endeavour. This resulted in increased uncertainty amongst the employees, who indicated their need for more information on DT. BGG-1 for example mentions: "I thought [code-name of DT initiative] was the big new thing. But it's not really defined. I thought it should have been implemented now for two or three years already". Moreover, technologies were implemented without comprehensive complementary guidelines on how to use them, their associated responsibilities, or the opportunities they provide for collaboration. The lack of DT progress also caused employees to question the ability of AirTrans to change: "If you can change something, I will cross my fingers, because […] we are discussing the same problems since 2010" (CG-3). Consequently, the past challenges have led the employees to lack both confidence in and a sense of credibility for DT-related information, invoking more IQ issues.

As such, we followed the hybrid approach of Woodall et al. (2013) for developing a tailored IQ assessment framework to assess the IQ *status quo* of AirTrans (see Figure 3). First, in collaboration with the top management, we determined the processes that had to be examined, which guided us to focus on the functional and supporting processes, while the operational ones (e.g., flight scheduling) were not directly included as a focus in our assessment. In the second step, we identified the main problems experienced by the employees. Our interviews with the top management revealed nine IQ-related problems, two of which were regarded as the most critical by the top management, namely that the available information was (i) generally not easily and quickly retrievable, and (ii) frequently not up to date for the required task/decision. While we examined if these problems were also shared by the rest of the employees, we did not limit our investigation solely to these two problems. The interviewees were allowed to discuss the problems that they were experiencing. The information items depicted in step three represent the relevant information values, attributes, tables, IS, paper files, etc. which were subject to the IQ assessment (Woodall et al., 2013). These items included all information required, created, stored, and exchanged as part of the functional and supporting processes of AirTrans.



1. Process	Selecting business processes that will be included in the assessment.
2. Problems	Identify IQ problems as perceived by management in the selected process.
3. Items	Relevant information items are determined on the basis of the problem identified.
4. Dimensions	Relevant dimensions for the identified problems and data items are selected.
5 Metrics	Appropriate metrics for the dimensions are determined.
6. Measure	Perform the selected measurements.
7. Analyze	Analyze the findings from the measurements.
8a. Costs	Determine the costs of the IQ problem.
8b. Costs	Model the processes

Communicate and expose	Communicating the project throughout the organization, including the top management. This is an on-going activity.

FIGURE 3 Information quality (IQ) assessment framework based on Woodall et al. (2013)

Then, in step four, we included in our analysis all IQ dimensions (Table 1). Based on the initial discussions with the top management, we chose to focus on subjective metrics. Hence, we built on a widely-accepted subjective IQ measurement tool (Lee et al., 2002), that we adapted to a semi-structured interview protocol. Our motivation to use interviews instead of a survey for identifying the IQ *status quo* was to (i) shed light on how information was being processed, (ii) what IQ issues existed and why, (iii) what consequences and costs they resulted in, (iv) what solutions had been tried to overcome such issues, and (v) what were employees views for moving forward. Hence, our measurement as portrayed in Figure 3 (step 6) did not include any objectification of subjective constructs but was rather aimed at understanding how employees perceived the level of IQ. Based on the interviews, we created *status quo* process models (step 8) and compared them with existing models that AirTrans had created.

As IQ issues can affect the entire organisation, we included interviewees from all divisions of AirTrans in our assessment. In doing so, we found that *timeliness*, *accessibility*, *and accuracy* represented the three main IQ issues hampering information retrieval and processing for the tasks at hand. Most of our interviewees indicated that finding information was difficult and time-consuming, especially for newcomers. Novel digital technologies were largely absent at the point of our diagnosis, while processes and activities related to information processing were conducted manually, such as data analyses. Some technological solutions, like a central intranet for storing and sharing information, were implemented to enhance the ability to process information and improve IQ, yet in practice did not yield the desired results. The lack of a clear assignment of responsibilities, as well as the absence of clearly defined processes, policies, and guidelines, were identified as major causes. Moreover, AirTrans lacked an overall approach towards IM, giving rise to various practices and routines in the

branches of the organisation. This, in turn, led to the creation of information silos that made it almost impossible for employees to understand key information outside of their silos. CIVB-1 explains: "Well, my honest opinion is that we still have too many islands. People do not communicate enough with each other, or they do not follow the chain of hierarchy".

The processes, practices, and routines that were part of such silos, as well as the perception of the level of IQ, was influenced by both organisational and individual characteristics. One clear individual characteristic that affects subjective IQ is the national background of employees. For example, when considering written information, there is a different perspective of conciseness; while some employees considered elaborate pieces of information to be of high quality, others perceived the same pieces of information to be of poor quality. The different backgrounds of employees, along with the high turnover experienced in military organisations (on an average of three years per employee), further contributed to inertia, resistance to change, and the creation of information silos. LCD-1 explains: "Especially since every two- or three years people go home and you get a new group of people, who are brought up in their own country, with their own rules, their own culture, and all of a sudden they have to change".

Moreover, the clear hierarchy and command-and-control structure of such a military organisation can affect how employees perceive the level of IQ since information coming from lower-ranked levels of the organisation is perceived to be of lower quality than information coming from the top. Specifically, employees in the lower ranks of AirTrans assume and trust that all information shared by the command group is of high quality. CF-1 mentions that quality is determined by the top management: "For our division, the quality is always judged by the command group". Consequently, employees spend more time processing information coming from lower levels due to perceived IQ problems, which was seen as a challenge for the top management since it increases IPR. CDG-1 elaborates on dealing with information from subordinates: "This is always in a military hierarchy. You have to consistently look after [lower ranking officers] until you know that a guy is disciplined enough to do it correctly by himself". Bearing in mind the short tenure periods, once newcomers are fully accustomed to the way of working at AirTrans and the top management can eventually trust that the information they produce and share is of high quality, their tenure period is already nearly coming to an end.

In summary, we find that the level of IQ affects OIP, and its requirements were influenced by how employees perceived IQ. Such perceptions affected how much time and energy the employees spent on processing information. Moreover, differences in IQ perceptions amongst employees can lead to disagreements during decision-making. Hence, our interviews reveal that perceptions of poor IQ invoke uncertainty and, thus, affected IPR. We find that the IQ issues had implications for the necessity and intensity of three main information processing tasks, namely (i) retrieving, (ii) storing, and (iii) sharing information. More specifically, the IQ issues increased IPR, as time and resources had to be invested to promptly gain access to all necessary information. In turn, the IQ and information processing issues affected the performance of the organisation through: "[b]udget loss, insufficient use of available air assets, and with that loss of capacity" (*LCD-1*). To address some of these IQ-related issues, AirTrans had incorporated (or had attempted to incorporate) various technologies to enhance information processing and improve the level of IQ, but no improvements were harnessed in practice. Such challenges were linked to the absence of activities concerned with governing IQ. Founded on OIPT as our focal theory, we aimed to increase the fit between IPR and IPC to address the IQ-related issues through an IQS, thereby supporting AirTrans in effectively navigating its DT.

4.2 | Action planning phase and intervention phase

Based on the results of the diagnostic phase, we developed an IQS in collaboration with the top management and implemented it as a business case. CAR enabled close collaboration with the top management, while the employees provided us with insights from various organisational levels. By collaborating primarily with the CIS branch, we created drafts of the IQS before agreeing on the final one to be developed and implemented. As alignment with organisational strategy and objectives is crucial, we reviewed organisational documents to ensure that the IQS would

contribute to the overall objectives of AirTrans. The overall strategy of AirTrans consists of short- and long-term objectives and tasks, most of which cover operational processes, such as optimising air-to-air refuelling and aeromedical evacuations. The main priority, however, was to increase efficiency, enhance internal processes, and improve standardisation amongst stakeholders. The top management, therefore, indicated from the beginning of the project their will to proceed with a DT endeavour, even though they had experienced significant challenges.

Based on our findings from the diagnostic phase, we divided the IQS solutions into *technology* and *IQ governance* ones. Hence, some of the solutions included in the IQS consisted of IT adoption, while others were focused on SQ improvements such as a cloud solution, and organisational improvements, such as process improvements (Appendix B). The appropriate technologies were derived from the *status quo* assessment as well as insights from the literature, a brief description of which was included in the IQS. This description touched upon the prior DT failures and their causes, as well as the identified IQ issues, and their effects on IPC. Besides IT adoption, our solutions revolved around governing IQ (Appendix C), as we found that the prior incorporation of technologies at AirTrans should, in theory, have resulted in an increase of IPC and IQ but were not experienced as such in practice by the interviewees. Consequently, the IQS we developed and implemented, explicitly mentioned, for instance, who should be responsible for which information, processes, and tasks to improve and sustain IQ. The data governance-related solutions are expected to influence IPR, through their direct impact on IQ.

While we present an overview of all solutions in Appendix B and Appendix C, for illustration purposes we briefly elaborate on one specific technological solution as well as the related IQ governance solution; specifically, the implementation of a cloud solution (technology) and the related governance activities (assigning accountability and responsibility, defining policies, etc.). As identified during the diagnostic phase, AirTrans was experiencing IQ challenges due to the absence of adequate controlled access to information from outside its HQ. This was especially vital for aeromedical evacuations, as well as the development of air-traffic manuals and rules involving extensive information exchange with external stakeholders, which lacked a single point of entry. Innovative solutions had not been identified due to the rigid and restrictive environment of military organisations, causing a mismatch between IPR and IPC. IQ issues related to accessibility, timeliness, and accuracy increased the efforts necessary for processing information, causing an increase in IPR. In collaboration with AirTrans and their civilian IT supplier, we identified a way in which a cloud solution could be implemented to resolve these challenges. Based on our diagnosis of prior DT failures at AirTrans, we ensured that we had an equal focus on the necessary IQ governance mechanisms that needed to be put in place. Consequently, we expected that the technological solution would increase IPC, and together with the focus on IQ governance, it would improve IQ and IPR.

Besides a description of the solutions, the IQS included a separate IQ mission and vision statement to ensure that its importance and objectives were known and understandable, and to justify the need for certain changes throughout the organisation, to reduce resistance to its implementation. We further explained how the solutions were expected to affect IPR and/or IPC; the two critical aspects of OIPT. The implementation of the IQS consisted of a presentation of the business case and the implementation of various solutions (e.g., defining accountability, promoting the use of the intranet, and implementing a cloud solution), whereas the other solutions are in progress. AirTrans has, for instance, initiated close collaboration with a civilian engineering company to further ensure access to its information from various dispersed geographical locations. The implementation activities were executed by members of our research team and the CIS branch, supported by the top management of AirTrans.

4.3 | Evaluation phase

The IQS was evaluated through a third round of interviews with employees and the top management (see Table 3). The interviewees from lower ranks acknowledged that an official order from the top management regarding the implementation of the IQS was indeed necessary and addressed the role of the division heads, as indicated "we are

lucky because we are in a military system, so once somebody gives you an order, you have to obey, so that is going to be easy for us. If the order is given by the chief of staff to adopt this strategy, it is going to be easy" (CI-1). The third round of interviews further revealed that the IQS increased the satisfaction of employees at all organisational levels, as they were satisfied with their participation in the project and the paid attention to the issues they were experiencing: "I am happy that such things are taken into consideration. Because since I am here, these have been continuous issues" (CF-1). While AirTrans had tried to address these IQ issues through their DT endeavour in the past, this had failed. The employees appreciated that they were involved in the DT process and were able to better understand what the organisation is trying to achieve and move towards. Moreover, the interviewees agreed that the IQS was needed and that it could continue to improve the level of IQ by addressing information processing, the satisfaction of employees, and the operational efficiency of AirTrans. As such, the interviewees recognised the need for adopting the IQS, since it addressed their most pressing issues.

By implementing a number of the proposed solutions, we were able to ask interviewees for an evaluation. Focusing again on the cloud solution and the related IQ governance solutions, the interviewees agreed that the cloud solution enabled effective and efficient information-sharing and, hence, increased IPC. In the case of a medical emergency, for example, external parties can now quickly and securely share information that can immediately be processed. LCD-1 adds to this: "The cloud solution works extremely well for AirTrans. Especially when you look at training and exercises and the functional division, you see that the cloud solution is perfect". It was further acknowledged in an interview that a focus on IQ governance, in collaboration with the employees, who would be the end-users of the implemented digital technologies, enabled the exploitation of the IQ benefits that the cloud solution offered: "[…] more formalizing, even putting more or better processes in place, that there is not so much possibility of misunderstanding, that you have straight information to deal with, […] everything's probably simply implemented and [AirTrans] can simply start working. Not having to request additional information". By assigning responsibility and accountability to the cloud solution, as well as providing complementary guidelines, we ensured improvements in IQ and a decrease in IPR. As a result, the fit between IPR and IPC was enhanced, which was the ultimate objective of our IQS. LCD-1, for example, mentions: "Requirements went down in terms of physical meetings, briefings, and reporting due to improved availability of information that can be retrieved from the cloud and can easily be distributed by the originators". Moreover, some interviewees from the functional division of AirTrans mentioned that the implemented solutions enabled them to complete projects together with the participating nations within three months on average, compared to eight months before the IQS.

When asked about the impact of the IQS on daily tasks, CB-1 answered: "I will now have more time to do my job as many people are at my desk asking for information that got lost in transition". Finally, the IQS we developed and implemented provided a clear DT vision, and the involvement of employees was seen as a transparent move, decreasing, thus, resistance to change. For instance, LCD-1 mentioned that: "[the employees] keep on going and they even go in those areas where they normally would have refused to make some changes". The top management considered this a major gain and was a trigger to set change in motion: "If we do not do this, we do not have to go to the next step. Because if we keep on messing around, then every tool we are going to bring in is going to be less effective than it should be" (LCD-1).

4.4 | Reflection phase

During the reflection phase, we evaluated our intervention together with the top management of AirTrans, based on the principles of Davison et al. (2004), as supplemented by Davison et al. (2012). During our final meeting with the top management, we determined if the research project resulted in a positive outcome and further reflected on the strengths and weaknesses of our implemented approach. As indicated by the top management, one of the major strengths of our approach was the involvement of employees from throughout the organisation, which provided transparency and reduced resistance to change concerning the DT endeavour. A quote

from CF-1 highlights this: "Exactly what we needed, external eyes to really stress on all the issues that we have. I am not surprised, but it is nice to have clearly mentioned all the issues that we are facing [...]". Whilst we could only observe the short-term effects, AirTrans has fully adopted the IQS and continues with the navigation of their DT accordingly.

We also reflected upon OIPT, which was chosen as our focal theory after the second round of interviews. Whilst other frameworks or theories including IQ (e.g., DeLone & McLean, 1992) might have been suitable as well, we found that the context and process of DT require a perspective that goes beyond the mere success or failure of IS implementation. This was confirmed in the diagnostic phase of our study, where we identified that prior technological solutions had been implemented that could have improved IQ but in practice did not. Hence, we built upon OIPT as a theoretical framework that explains why and how information is crucial for organisational performance, and how organisations can engage in DT to realise this.

One drawback of the OIPT literature is that it conceptualises IQ primarily through the richness of information (e.g., Daft & Lengel, 1986), paying scant attention to its other inherent characteristics. One of the key assumptions of OIPT, however, is that organisations need high-quality information to deal with environmental uncertainties and to improve decision-making (Galbraith, 1973). Our first analysis associated with the issues faced at AirTrans revealed that both objective and subjective aspects of IQ can significantly influence information processing in organisations. Although there might be other ways to improve the level of IQ, and consequently successfully navigate DT, an IQS was deemed the most appropriate way for bringing balance between IPR and IPC and was specifically instrumental in the case we explored in our study. We present a reflection on the complete CAR project in Appendix D.

5 | DISCUSSION

5.1 | Key findings

Our study provides a unique opportunity to explore the role of IQ during DT and examine in practice how pre-digital organisations can effectively navigate them. When it comes to our key findings, we bring forward three main contributions to the extant IS literature, as our study elucidates (i) the implications of the level of IQ for organisational information processing, (ii) the role of IQ in DT endeavours, and (iii) how an IQS can help pre-digital organisations navigate DT. In the case of AirTrans, we identified issues related primarily to three IQ dimensions, namely: *accessibility*, *timeliness*, and *accuracy* of information. Employees throughout the organisation were facing difficulties in retrieving appropriate information and determining whether it was up-to-date and accurate. Our findings indicate that employees had a lot of freedom in managing information, and consequently information was managed per unit, leading to information silos. Concurrently, employees from different nations had varying perceptions of what entails high-quality information, which affected the IPR at AirTrans, and led to differences in managing information per unit. Such IQ issues, therefore, gave rise to uncertainty and primarily increased the required effort in retrieving, storing, and sharing information, ultimately affecting information processing. While technological solutions had been implemented in the past to improve information processing as well as the level of IQ, these did not yield the desired results in practice. We find that a lack of focus on governing IQ played a major role in such a failure, which corresponds with the notion that DT entails much more than the mere implementation of digital technologies (Kane et al., 2015; Vial, 2019).

Hence, we also demonstrate that improving the level of IQ can serve as an implicit driver, problematic enabler, and beneficial outcome of DT. On the one hand, therefore, we offer novel insights into DT challenges caused by IQ issues, while on the other hand, we unearth DT-related opportunities for increasing the level of IQ. As a pre-digital organisation, AirTrans had no digital technologies in place and experienced significant IQ issues. Such issues also affected the effectiveness of their DT endeavour, causing a lot of uncertainty amongst

employees and resistance to change. AirTrans lacked a clear strategic view of IQ, as well as a clear DT vision, and was not transparent enough about its DT motives and approach. Such obstacles, thus, were largely reflected by the IQ-related issues experienced by the employees at AirTrans, although the top management did not identify them as such initially.

Third, as a response to the identified issues, we designed and implemented an IQS, aiming at aligning IPR and IPC. Our IQS derived technological and IQ governance solutions from a tailored *status quo* assessment, which, as demonstrated during the evaluation phase, ultimately enhanced information processing, and supported AirTrans in navigating its DT. Overall, the employees were satisfied with the attention that was paid to their issues, as well as with the concrete plan that we developed and implemented for overcoming them. The implementation of various solutions did not result in resistance from stakeholders, thereby showing how an IQ assessment followed by the development of an IQS that balances both technological solutions and IQ governance can contribute to successful DT.

5.2 | Linking DT, OIPT, and IQS

While the concepts of DT, OIP, and IQ have been previously examined in isolation, the unique opportunity to conduct a CAR project at AirTrans revealed that they are closely related and have an influence on each other. Our CAR approach, therefore, further resulted in a conceptual model, which we visually depict in Figure 4. First, we elucidated the implications of IQ for IPR, as poor-quality information results in increased levels of uncertainty. We found that the implementation of technology, as indicated in the literature (e.g., Zhu et al., 2018), indeed results in improved IPC. For technology to result in improved IQ, however, IQ governance mechanisms need to be in place. While prior research states that governance mechanisms directly influence IPC rather than IPR (Oshri et al., 2019; Tushman & Nadler, 1978), our findings indicate that appropriate IQ governance mechanisms decrease IPR by improving IQ. That

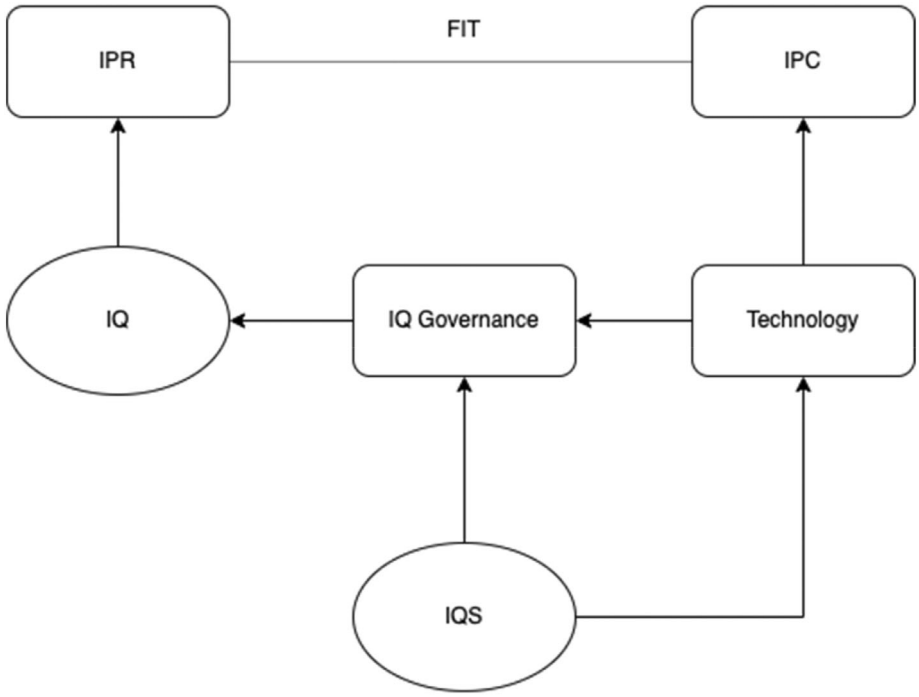


FIGURE 4 Conceptual model

is, the incorporation of technological solutions allows for potential improvements in the level of IQ, while IQ governance ensures that these improvements can be exploited. By systemically addressing both technology and IQ governance, an IQS sets the scope for DT and contributes to achieving a fit between IPR and IPC, thereby supporting organisations in effectively navigating their DT.

5.3 | Implications for theory

When it comes to the theoretical implications of our work, we identify novel links amongst the concepts of DT, IQ, and OIP in the context of pre-digital organisations. While prior studies have started unravelling some of the complexity associated with the successful navigation of DT (e.g., Verhoef et al., 2021; Vial, 2019), and are beginning to focus specifically on pre-digital organisations (Chanias et al., 2019; Sebastian et al., 2017), most DT endeavours still fail in practice (De la Boutetière et al., 2018), and the topic, therefore, remains timely for IS research. We demonstrate how pre-digital organisations can set a DT scope and navigate their endeavours by implementing an IQS focused on both technology as well as governing IQ. The literature indicates that access to information is a key enabler of, and a driver of DT (Chanias et al., 2019; Vial, 2019) while pointing to the potential implications of digital technologies for improving IQ (e.g., Setia et al., 2013) as well the potential risks (Clarke, 2016). Considering these insights, including the difficulties of navigating DT in practice (De la Boutetière et al., 2018) as well as addressing the level of IQ (Işık et al., 2013), we further examined the role of designing and implementing an IQS in the context of DT.

In doing so, we first demonstrate the implications of IQ-related issues by adopting OIPT as our theoretical lens (Galbraith, 1974). Although the extant literature acknowledges the importance of obtaining a fit between IPR and IPC to increase organisational effectiveness (e.g., Premkumar et al., 2005; Srinivasan & Swink, 2018) and has started examining OIP in the context of DT (e.g., Aben et al., 2021), the majority of OIPT studies have focused solely on the quantity of information (e.g., Tushman & Nadler, 1978; Zhu et al., 2018), neglecting the implications of quality. Nevertheless, Daft and Lengel (1986) have pointed early enough to the crucial role of IQ, which at the time they conceptualised solely as information richness. In line with other scholars (e.g., Abraham et al., 2019), we argue that IQ is becoming increasingly crucial since contemporary organisations can have access to more data from a variety of different sources. We have incorporated the multidimensional nature of IQ and examined its implications for OIP. We show that poor IQ increases IPR, thereby affecting the fit between IPR and IPC. Moreover, we elucidate differences in perceived IQ related to employees' positions in the organisational hierarchy. More specifically, information is perceived to be of higher quality when it is shared by employees with a higher rank. Such differences in IQ perceptions might also exist in terms of data originating from sources outside the organisational boundaries. Novel insights into IQ are especially valuable considering that the increasing access to large amounts of data from a variety of sources can pose threats to the level of IQ (Abraham et al., 2019; Clarke, 2016). As such, the *quality* of information, rather than the quantity, is increasingly becoming a key concern for organisations, which is also evident by calls in the literature to examine the role of IQ in OIP (e.g., Hazen et al., 2014).

Second, while DT offers opportunities for organisations to improve their level of IQ (e.g., Côrte-Real et al., 2020; Janssen et al., 2020; Taleb et al., 2021), we show that the IQ *status quo* of pre-digital organisations can give rise to additional complications by causing uncertainty and increased IPR. Indeed, having access to high-quality information can be an implicit driver for DT, yet generating access to such information requires, in the first place, the successful implementation of digital technologies. Prior studies have established that poor IQ can hamper the effective execution of processes (e.g., Gharib et al., 2018), and we confirm this in the context of DT. As illustrated in our case, such endeavours might be less effective when organisations primarily focus on technology, neglecting solutions and activities focused on governing IQ. The extant literature on DT, however, largely neglects the importance of IQ and data governance. Our findings demonstrate that if organisations want to fully harness the possibilities that digital

technologies can offer for IQ improvement and aim to increase their chances of successfully navigating DT, they need to strategically address IQ.

Third, we provide concrete insights into how organisations can successfully navigate their DT by designing and implementing an IQS. While organisations are becoming increasingly aware of the importance of IQ (Madnick et al., 2009), prescriptions as to how they can strategically address IQ-related issues are scarce in the literature (e.g., Petter et al., 2013). We, therefore, contribute to the extant DT research agenda by establishing that organisations can set the scope for DT by designing and implementing an IQS consisting of targeted initiatives. Considering that, in practice, resistance to change is a major barrier to the success of DT (e.g., Fitzgerald et al., 2014; Vial, 2019), we show that such an IQS can immediately assist employees in understanding the DT-related efforts of the organisation, thereby reducing uncertainty and leading to increased employee satisfaction as well as their decreased resistance to change in DT-related initiatives. By focusing on both IQ governance as well as the underlying technology, organisations can ensure that the potential of IQ improvements, as enabled by digital technologies, can be indeed harnessed.

5.4 | Implications for practice

In this study, we explore the role of IQ during DT of pre-digital organisations. As organisations are increasingly relying on data and information from a variety of sources, ensuring a high level of IQ becomes a significant challenge that requires pre-digital organisations to understand IQ-related issues, assess their IQ *status quo*, and strategically approach IQ to remain relevant in the digital age. Our findings demonstrate that DT can be driven by the implicit need to improve the level of IQ, which in turn can improve OIP. Simultaneously, however, the IQ *status quo* of pre-digital organisations might hamper the effective execution of DT. As such, our findings offer novel insights and valuable recommendations for practitioners who need to successfully navigate DT and avoid pitfalls. More specifically, we illustrate that DT challenges can be attributed to a lack of a clear vision, inertia, uncertainty, and resistance to change, while such barriers can be linked to a poor level of IQ, since information about the DT endeavour can, for instance, be hard to access or understand, or might not be updated regularly. Such issues might primarily exist in the context of pre-digital organisations that do not have any digital technologies in place and have limited understanding of and experience with the implementation of such technologies. To improve the level of IQ through the adoption of digital technologies, however, there is a need to design and implement targeted IQ interventions that include both technological and governance solutions.

Such interventions should be part of a broader IQS incorporating both digital technologies as well as IQ governance solutions. The latter should not be overlooked, as pre-digital organisations, such as AirTrans in our case, might focus solely on digital technologies and their potential, but IQ governance solutions can ensure that these can be exploited. Hence, practitioners should be aware that a sole focus on technology will not yield the desired results, as our findings show. To design and implement an IQS, organisations must be aware of their IQ *status quo* and identify IQ issues and their causes. As we show, the development of a tailored IQ assessment framework can yield important insights into what IQ issues are experienced, what causes them, and what consequences they have. Such a tailored approach is necessary, as unique organisational characteristics can influence the level of IQ and, thus, the appropriate solutions. While organisations are becoming increasingly aware of the value of IQ, we urge practitioners to pay more attention to the level of IQ in their organisations. Our findings indicate that poor IQ has direct implications for organisations (e.g., budget loss), and increases the requirements for processing information. Considering the importance of fit between IPR and IPC for organisational effectiveness, an imbalance can have adverse effects on operations.

Consequently, practitioners can choose to focus on reducing IPR, enhancing IPC, or both, to address the higher level of IPR caused by poor IQ. Digital technologies offer opportunities for both enhancing IPC as well as reducing IPR through their impact on IQ, making DT especially relevant. As most DT endeavours fail in practice, organisations must become aware of how they can successfully navigate them. Our findings indicate that an IQS can help pre-

digital organisations to set the scope for DT, thereby enhancing the chances of DT success. A detailed IQS that addresses the IQ issues identified through both technological and IQ governance solutions leads to an improved level of IQ, reduced IPR, and enhanced IPC.

Additionally, our study provides rich insights regarding the engagement of an external team of researchers in an organisation during DT. Together with the top management of AirTrans, we reflected on the added value of the CAR approach and the engagement of the research team, and we identified the strengths of our approach for all phases of the research project. During the diagnostic phase, the independence of the researchers helped to generate a thorough and detailed understanding of the *status quo*. Whereas managers are often consumed by work and cannot always find the time to communicate with many stakeholders, the researchers were able to interview employees from various levels of the organisation. Especially the military context of our case allowed the employees from throughout the organisation to speak freely without fear of potentially adverse consequences. Considering that most DT endeavours are perceived as failures (De la Boutetière et al., 2018) and resistance is a key cause (e.g., Vial, 2019), such open conversations with employees can facilitate a more thorough understanding of why prior initiatives had failed, and why external involvement might indeed be beneficial for pre-digital organisations (Siachou et al., 2021).

Besides that, the top management of AirTrans indicated that it was hard for them to understand theories that might have been useful, whereas the research team was able to (i) use instrumental theories to thoroughly understand the situation at AirTrans, and (ii) apply a focal theory that guided action planning and intervention. While also generating scholarly knowledge and contributing to theory, the involvement of an external research team can bring valuable knowledge to the organisation through the application of theoretical insights. Such a systematic approach can further induce confidence in the findings and the strategy for improvement amongst stakeholders, thereby reducing resistance to DT-related change in the organisation.

5.5 | Limitations and future directions

Although we followed a structured and thorough research design, as indicated by the CAR approach, some limitations need to be acknowledged that concurrently can present avenues for future research on the topic. The first limitation of our study naturally emerges from its research context. While AirTrans is a pre-digital organisation, it represents a unique organisational setting of significant operational complexity, and our findings might relate to factors that influence the level of IQ primarily in the broader context of military organisations. Our study portrays factors that can influence the level of subjective IQ, namely employees' background, tenure, organisational culture, and hierarchy. We uncover, for instance, that information originating from higher levels of the focal organisation is perceived to be of higher quality than information originating from lower in the hierarchy. To this end, we encourage future research endeavours on the topic to focus on other organisational settings, for confirming our findings, as well as for identifying other factors that could have an impact on the level of subjective IQ. Differences in IQ perceptions might be more prevalent, for instance, when data comes from a wide variety of different sources and could have significant implications in settings such as inter-organisational data exchange (Nicolaou & McKnight, 2006).

We also encourage future research to further examine how such differences can affect aspects of organisational performance, such as decision-making. Besides that, in organisations where the command-and-control hierarchy is less prevalent, it might be necessary to seek a consensus regarding the depth and breadth of the incorporated IQ dimensions, which can also motivate future studies. Navigating DT and dealing with IQ-related issues, however, can give rise to challenges for any organisation, and our approach to assessing and addressing the level of IQ can be applied in settings beyond military or pre-digital organisations. The idiosyncratic nature of AirTrans, therefore, does not hinder the generalizability of our findings, and we encourage future research to further explore the topic within both non-profit as well as for-profit organisations to further confirm as well as expand the findings of our study.

Other limitations related to our approach should be acknowledged as well. AR is often, even if inaccurately, criticised for its lack of rigour and repeatability (e.g., Avison et al., 2018). Following Davison et al. (2012), we have paid attention to the application of theories to guide our intervention, and we extensively documented all the steps of our process, which can enable other researchers and organisations to replicate it. Moreover, whilst we demonstrate how dimensions other than information quantity or richness affect OIP, we do so within an arguably short timeframe, which might be considered a limitation. Relatedly, given that the DT of AirTrans is ongoing, additional implications and insights might be unearthed through further CAR cycles. The use of a single CAR cycle, thus, represents another limitation. A long-term project has, however, already been agreed upon with the top management of AirTrans to further assess the influence of IQS on DT and OIP, and we, thus, suggest that future research could also examine this relationship further in a different context.

Considering that organisations aim to gain access to increasing amounts of data that often have an unstructured nature (Clarke, 2016), we believe that future research should re-examine the different IQ dimensions and whether potential trade-offs between different IQ dimensions exist in light of new digital technologies and techniques. Our focus on pre-digital organisations that have no experience with using digital technologies has led us to mainly use widely known IQ dimensions while asking open questions to the interviewees about any other dimensions they may deem important. We believe, however, that new IQ dimensions might emerge, or existing dimensions might change in light of digital technologies. Our examination does not include an exploration of such new dimensions and, therefore, we encourage future research to re-evaluate the existing IQ dimensions. Relatedly, future research can further examine how data governance should be set up in organisations that are already more mature in their DT. Moreover, different digital technologies might have different implications for IPC and IPR, which could be further explored in future studies. In general, our study unearths IQ-related insights for organisational operations and, more specifically, DT endeavours, and we see merit in this being further pursued by IS scholars in future studies.

6 | CONCLUSION

Organisations these days actively engage in DT to gain access to increasing amounts of data from various sources, posing threats to ensuring a high level of IQ. Especially pre-digital organisations face difficulties in navigating DT due to their fragmented experience with, and knowledge of digital technologies. We explore the critical, yet limitedly examined the role of IQ for OIP and delineate how the design and implementation of an IQS can support pre-digital organisations in navigating their DT. We conduct CAR at a military organisation and elucidate how poor IQ increases IPR, thereby serving simultaneously as an implicit driver as well as a barrier to the successful navigation of DT. We further develop and implement an IQS that focuses on both technology as well as IQ governance, aiming to enhance the fit between IPR and IPC. Our findings delineate that such an IQS can support pre-digital organisations in successfully navigating their DT. Our work is timely and topical for both IS research and practice and delineates opportunities for future research.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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APPENDIX A: EXAMPLE DATA STRUCTURE

See Figure A1.

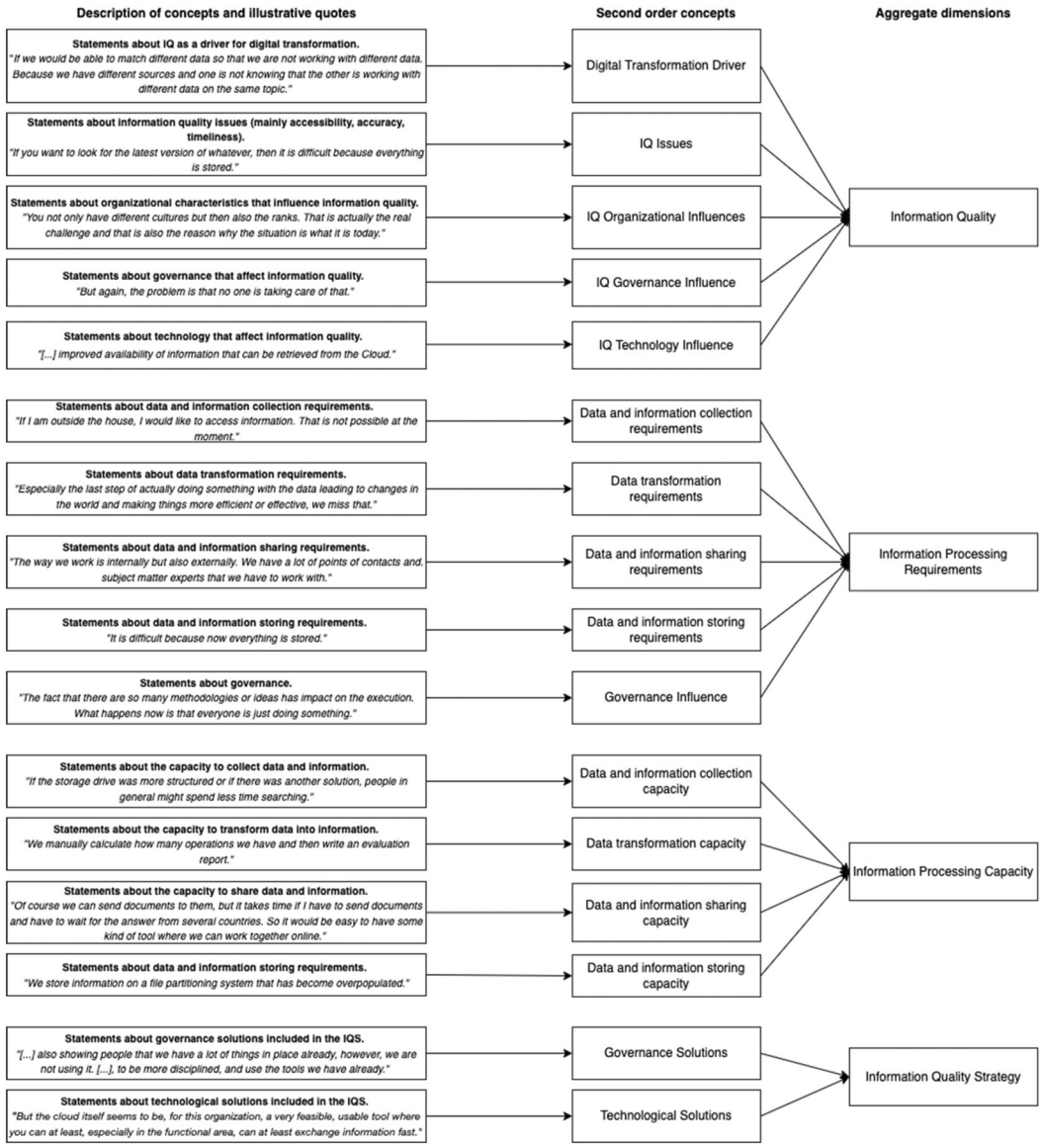

FIGURE A1 Data structure

APPENDIX B: IQS—IQ GOVERNANCE SOLUTIONS

See Table B1.

TABLE B1 IQ Strategy (IQS) Information Quality (IQ) Governance Solution

Solution	Status quo	Description	Possible IQ implications	IPR implications (need to process information, affected by the extent of uncertainty and complexity)
Set up IQ and DT governance mechanisms	AirTrans is characterised by high levels of interdependence between different branches and divisions, as well as with external parties such as the participating nations. Governance mechanisms (defined accountability and responsibility) were, however, not properly established and information silos were present	Governance mechanisms can assist in deconstructing information silos (Abraham et al., 2019; Zhang et al., 2022). Tactics for ensuring accountability of information include sharing explicit knowledge of the information chain (process flows), seeking input from information producers to get them involved, and including IQ goals in performance evaluations (Sebastian-Coleman, 2012). Division heads must become responsible for the storage, sharing, and structuring of information in their division. The division heads are, in turn, given the task to assign clear responsibilities and rules for employees within the division and should monitor conformance to these rules. The same principle applies to specifying who oversees DT within the organisation. If this is known throughout the organisation, employees will know whom to reach out to for information about the DT endeavour	Improvement of *accessibility*—Improvement of the ease with which information can be retrieved as it becomes clear what stakeholder is responsible for what kind of information Improvement of *appropriate amount*—By assigning responsibility and accountability, stakeholders will be more inclined to ensure sufficient (but not too much) information is available	*Reduced IPR*—The interdependence between the different branches of AirTrans and external stakeholders leads to higher levels of uncertainty, thereby affecting IPR (Tushman & Nadler, 1978). By clarifying who is responsible for what kind of information, accessibility and an appropriate amount of information will increase, thereby reducing some of the uncertainty inherent in the interdependence and reducing IPR

TABLE B1 (Continued)

Solution	Status quo	Description	Possible IQ implications	IPR implications (need to process information, affected by the extent of uncertainty and complexity)
Creating instructions for cleaning existing information	Related to solution one, AirTrans had an abundance of information for which no one felt responsible, resulting in too much information being available, causing uncertainty and questions about the timeliness and accuracy of information. Employees indicated that they had to put a lot of effort into processing information for each task, as information either could not be found, or it was unclear whether the appropriate information was consulted	After assigning responsibility, instructions had to be created for how to clean the existing information. Information that needs to be saved should be given a clear name according to a new naming convention. This way, the organisation would have a clean and accurate inventory of information that would eventually be transferred to new IT solutions. "Garbage-in, garbage-out" (LCD-1) can be avoided in this way	Improvement of *appropriate amount*–By reducing the amount of information (duplicates, outdated information) Improvement of *accuracy*–By removing outdated information Improvement of *accessibility*–By reducing the amount of information available Improvement of *timeliness*–By ensuring that outdated information is removed	*Reduced IPR*—We expect that the requirements for processing information decrease after implementing this solution, as the information processing process (collecting, transforming etc.) will speed up by reducing the amount of irrelevant and/or inappropriate information.
Creating guidelines per division for storing information	Related to the previous solutions, there were no rules as to how data and information should be stored. Regardless of the technological solution in place, there should be at least clear guidelines as to how to do so	After cleaning, every division (under the supervision of the division head) should create clear guidelines on how to store information and share this in-house. While the previous measure is aimed to resolve the current issues, this measure should ensure that similar issues do not emerge in the future	Improvement of *appropriate amount*–By ensuring that only relevant information is stored Improvement of *accessibility*–By ensuring that information is stored properly, easily retrievable, and not too much information is stored	*Reduced IPR*–By improving the storage of information, it will become easier for stakeholders to retrieve appropriate information, thereby reducing the requirements to process information
Using Intranet functionalities	AirTrans had previously invested in the creation of an intranet portal. While this portal might not be state of the art, an observation of the intranet revealed that increased exploitation of this medium could solve some of the challenges faced by employees, as	Digital channels, such as an Intranet, can transform previously invisible into visible information and encourages innovation within organisations (Joseph & Gaba, 2020; Leonardi, 2014). As such, division heads are encouraged to share information	Improvement of *accessibility*–By providing a central place where internal stakeholders can retrieve information	*Reduced IPR*–By reducing the need to search for information in different places

(Continues)

TABLE B1 (Continued)

Solution	Status quo	Description	Possible IQ implications	IPR implications (need to process information, affected by the extent of uncertainty and complexity)
	it provides an opportunity for visualising information in a more structured and clear way. In the status quo, there was no description of responsibilities concerning the storage of information on the intranet (nor any other medium for that matter)	with employees through the intranet. To do so, new superuser accounts must be created and assigned so that displaying information on the intranet is not only a task for the CIS branch. For this, processes, guidelines, and rules must be developed to ensure that employees adopt the use of the intranet		
Using functional mailbox functionalities	Employees primarily used their personal email accounts, which led to a lack of transparency and, again, storage of information in different locations. This further caused an increase in IPR, as employees did not always have access to the appropriate information and were, therefore, required to collect information themselves	The use of functional email accounts, that were already in place, must be promoted throughout the organisation, setting the functional mailbox as the default account when drafting new messages.	Improvement of *accessibility*–By always allowing access to branch-related information.	*Reduced IPR*–By reducing the need to ask employees for information that is not accessible to everyone.
Providing training for newcomers	Newcomers now receive limited training in dealing with information. Especially since turnover is high (three years at the command on average), many different processes and ways of working have come to exist. This has caused a lot of uncertainty amongst newcomers on how to collect, store, and communicate information and they tend to use	As part of this solution, employees receive training about how to handle information (related to the previous solutions) to reduce the lack of standardisation arising from different nationalities, work experience etc	Improvement of *accessibility, appropriate amount, and timeliness*–By ensuring that employees follow the standardised information policies Improvement of *consistency*–By ensuring that there is as little variety between information formats as possible	*Reduced IPR*–Since employees are trained in where to find and store information, they will require less time to get familiar with this themselves (especially considering the tenure period)

TABLE B1 (Continued)

Solution	Status quo	Description	Possible IQ implications	IPR implications (need to process information, affected by the extent of uncertainty and complexity)
	the procedures and processes they are familiar with from their prior deployments. This further reduces standardisation and harmonisation and leads to higher levels of uncertainty throughout the organisation			
Reviewing the processes involved	The continuous focus on governance and IQ should also be ensured when new technologies are implemented	As shown in the past, the implementation of the tool itself is not sufficient to guarantee success or to exploit IPC improvements. It requires a change of processes, as well as the close involvement of different stakeholders. As such, a team should be ensembled to review all the processes that require new IS to define functional requirements, and consequently to model how processes will be changed after implementation	Improvement of *accessibility*, *appropriate amount*, *accuracy*, *and timeliness*–By ensuring that the functionalities of the new technologies are utilised properly	*Reduced IPR*–Since the implementation of technologies requires and/or induces changes to organisational processes, a review of these processes helps to understand and design policies related to the technology and results in the exploitation of the technology
Training employees and creating guidelines for new tools	The continuous focus on governance and IQ should also be ensured when new technologies are implemented	In terms of DT, training can help to show employees the potential benefits of digital technologies and reduce resistance (Svahn et al., 2017). These guidelines should complement the implementation of digital technologies. Training and guidelines are necessary to induce proper use of the provided tools	Improvement of *accessibility*, *appropriate amount*, *accuracy*, *and timeliness*–By ensuring that the functionalities of the new technologies are utilised properly	*Reduced IPR*–Proper usage of the new technologies will ensure that IQ dimensions can improve and, hence, that IPR can be reduced

(Continues)

TABLE B1 (Continued)

Solution	Status quo	Description	Possible IQ implications	IPR implications (need to process information, affected by the extent of uncertainty and complexity)
Providing DT-related training and workshops	There was a lack of understanding and transparency with regard to the DT initiatives of AirTrans, causing uncertainty and a lack of trust in the ability of AirTrans to improve. Information was primarily shared with top management	Workshops and training foster collaboration in DT settings (Svahn et al., 2017). To reduce uncertainty and resistance regarding DT, AirTrans need to involve different stakeholders (beyond the top management). In brainstorming workshops, stakeholders can indicate their challenges and potential solutions, similar to IQS interviews	Improvement of *accessibility, accuracy, and ease of understanding*–Through discussing and extensively sharing information about the DT endeavour in a way that is understandable and accessible for all stakeholders	*Reduced IPR*–Since stakeholders will know where to find relevant information regarding the DT endeavour and understand what is happening

APPENDIX C: IQS—TECHNOLOGICAL SOLUTIONS

See Table C1.

TABLE C1 IQ strategy (IQS) technological solution

Solution	Status quo	Description	Possible IQ implications	IPC implications (capacity to collect data, transform it into information, and communicate and store it)
Implementing a cloud solution	While the organisation had been experimenting with what they referred to as a Cloud solution, this was deemed unsuccessful as the organisation and its participating nations had issues adapting. Without such a solution, however, information about planning and executing medical evacuation missions were exchanged primarily via telephone communication. Getting access to complete information on time was, therefore, perceived as challenging	IS significantly enhances organisations' IPC (Tushman & Nadler, 1978). Cloud solutions provide on-demand access to information resources and support organisations in realising flexible innovative processes (Kane et al., 2015; Vey et al., 2017) just This solution should be an on-premises cloud solution, requiring an internal data centre. A privately hosted cloud solution (infrastructure-as-a-service, platform-as-a-service, or software-as-a-service) would not meet the security requirements. This solution would be especially relevant for the domain of medical evacuations and standardisation of air transport procedures amongst the participating nations	Improvement of *accessibility*–By offering a central place where both internal and external stakeholders can share information easily Improvement of *completeness*–By allowing stakeholders to fill in predefined forms, compared to telephone calls, as well as allowing for information exchange between parties that were first not directly connected Improvement of *timeliness*–By removing an additional layer of human involvement (writing down information shared via telephone) Improvement of *consistency*–By reducing verbal communication dependent on the employee at call	*Improved IPC*–Since the cloud solution significantly enhances the ability to collect and share information with (external) stakeholders

(Continues)

TABLE C1 (Continued)

Solution	Status quo	Description	Possible IQ implications	IPC implications (capacity to collect data, transform it into information, and communicate and store it)
Implementing collaborative workspaces	AirTrans is currently lacking many IT possibilities that could increase the capacity to process information, such as collaboration suites. Stakeholders experience challenges with information duplicates because of the inability to work collectively on a piece of information	This solution should allow for collaboration within AirTrans, as well as collaboration with external stakeholders. This would contribute to, for instance, the development of manuals and regulations that require data and information from various sources	Improvement of *accuracy, completeness, and consistency*–By ensuring that stakeholders work in the same information environment	*Improved IPC*–This would increase the ability to share and store data and information, especially in terms of collaboration with external stakeholders
Implementing a document management system	There was no document management–in terms of governance and technology–in place, which caused confusion amongst employees	A document management system makes information retrieval easier by facilitating the flow of information through an organisation and to ensure the availability of information upon request (Alshibly et al., 2016)	Improvement of *accessibility*–By making information retrieval easier (e.g., through smart queries) Improvement of an *appropriate amount, accuracy, and timeliness*–By automating functionalities such as archiving and detecting duplicates	*Improved IPC*–Ability to efficiently store and retrieve information would be enhanced
Implementing mobile solutions offering access to all information	Access to critical information (or any information for that matter) from outside the AirTrans building is currently not possible. These solutions are approached separately from the Cloud solution due to security restrictions	This solution should allow access to the primary IT network of AirTrans from various geographical locations. Realising such (mobile) access not only offers flexibility to employees in case working at the HQ of AirTrans is not possible, but also enhances connectivity, communication, and information exchange with people from mission areas, such as during a medical evacuation	Improvement of *accessibility*–By offering access to all the related information of AirTrans from dispersed geographical locations	*Improved IPC*–Improves the ability to collect and store information from outside the HQ of AirTrans

APPENDIX D: REFLECTION ON CAR

See Table D1.

TABLE D1 Reflection on canonical action research (CAR)

	Criteria	AirTrans CAR project
Researcher-client agreement		
Principle 1	1a. Did both the researcher and the client agree that CAR was the appropriate approach for the organisational situation?	Prior to the start of the project, the research team and AirTrans had various meetings discussing the appropriate approach for the research project and agreed on the added value of following the CAR approach.
	1b. Was the focus of the project specified clearly and explicitly?	The focus of the research project was established together with the top management of AirTrans (preliminary meetings and first interview round) and communicated to both internal and external stakeholders.
	1c. Did the client make an explicit commitment to the project?	AirTrans supported the project and allowed for the review of organisational documents, observations, and interviews. The Chief Operations Officer was appointed as the Executive Sponsor for the project, supported by the Senior Information Manager.
	1d. Were the roles and responsibilities of the researcher and client organisation members specified explicitly?	While the research team conducted an independent investigation, the expectations and responsibilities of both parties were known. Periodical discussions were initiated to prevent scope drift and AirTrans experienced a direct payoff.
	1 e. Were project objectives and evaluation measures specified explicitly?	The objectives and evaluation measures were discussed with top management prior to the project, as well as during the project.
	1 f. Were the data collection and analysis methods specified explicitly?	The data collection and analysis methods were discussed with the top management of AirTrans, who gave access to documents and interviews. The interviewees gave consent for audio recording.
Cyclical process model		
Principle 2	2a. Did the project follow the cyclical process model or justify any deviation from it?	The project followed the phases of the CAR methodology, although the project was constrained by a limited time frame.
	2b. Did the researcher conduct an independent diagnosis of the organisational situation?	The research (diagnostic phase) was independently conducted by the research team. AirTrans specifically requested this.
	2c. Were the planned actions based explicitly on the results of the diagnosis?	The planned actions, in the form of the IQS, addressed the challenges identified during the *status quo* assessment.
	2d. Were the planned actions implemented and evaluated?	The IQS was implemented and communicated throughout the client organisation. A third round of interviews allowed for the evaluation of the strategy.

(Continues)

TABLE D1 (Continued)

	Criteria	AirTrans CAR project
	2 e. Did the researcher reflect on the outcomes of the intervention?	While not specifically mentioned in the paper, feedback on the strategy by AirTrans personnel was used to improve the strategy
	2 f. Was this reflection followed by an explicit decision on whether to proceed through an additional process cycle?	There was not enough time to proceed with another cycle. However, AirTrans was encouraged to continue the project and later established a partnership with the research team for the continuation of the research project in the future. AirTrans has confirmed doing so
	2 g. Were both the exit of the researcher and the conclusion of the project due to either the project objectives being met or some other clearly articulated justification?	The objective of this research project, that is, examining the nature of DT and designing for successful DT in the future was reached. AirTrans will continue the DT process and the research team will be involved again in the future
	2 h. How was the independent diagnosis of the organisational situation conducted?	We interviewed employees from various organisational levels (rather than only top management) to get an overview of the *status quo*. Employees were informed that their answers would be dealt with anonymously and could not harm them in any way. No employees of AirTrans were involved in the interviews
	2i. Which instrumental theories did the researcher use?	We build upon the articles by Lee et al. (2002) and Woodall et al. (2013) for the IQ assessment
	2j. How were these theories selected?	After the first round of interviews with the top management of AirTrans, we conducted an extensive literature review to identify the appropriate instrumental theories
	2 k. How did these theories support the identification of the focal theory used to guide the changes?	We found a link between IQ, DT, and organisational information processing during the diagnostic phase. Hence, we chose OIPT as the focal theory, aiming to enhance the fit between information processing requirements and capacity
	2 L. Post-intervention, did the researcher reflect on the instrumental theories used and their suitability?	We reflected on the suitability of the hybrid framework and the semi-structured interviews
The principle of theory		
Principle 3	3a. Were the project activities guided by a theory or set of theories?	An extensive literature review was part of the study, and the planned actions were guided by OIPT literature
	3b. Was the domain of investigation, and the specific problem setting, relevant and significant to the interests of the researcher's community of peers as well as the client?	AirTrans was very satisfied with the research project and the outcome. Hence, the issues we identified were relevant to the organisation. The project identified a major cause of DT failure, addressed a gap in the literature on IQ, created an enhanced version of OIPT in the context of DT, and shows how organisations can successfully drive DT
	3c. Was an instrumental theory used to derive the causes of the observed problem?	We used the widely accepted questionnaire of Lee et al. (2002) as input for our hybrid approach (Woodall et al., 2013) to assess the *status quo*

TABLE D1 (Continued)

	Criteria	AirTrans CAR project
	3d. Did the planned intervention follow the instrumental theory?	By assessing the *status quo*, we were able to tackle specific IQ issues and guide the DT endeavour of AirTrans, using input from OIPT literature
	3e. Was the focal theory used to evaluate the outcomes of the intervention?	To evaluate the results, we build upon the *status quo* assessment interview protocol. Furthermore, we assessed the fit suggested in OIPT
	3f. Did a focal theory emerge from the situation or during the problem diagnosis?	Based on the interviews, we established OIPT as the appropriate focal theory
	3g. Was this focal theory acceptable to both the client and researcher?	AirTrans agreed on the importance of knowledge and deemed OIPT as the most applicable theory
	3h. What role did instrumental and focal theories play with respect to the diagnosis and the action plan?	After the first interview round with the top management of AirTrans, we established the theories as input for both the diagnosis (*status quo* assessment) and the action plan (IQS)
	3i. Were these theories evaluated for their applicability to the organisational context, considering current organisational practices?	For OIPT, see 3 g. For the IQ assessment, we explicitly chose to use the hybrid framework (Woodall et al., 2013), to ensure applicability
	3j. Did both the researcher and the client undertake this evaluation?	The research team and AirTrans had periodic meetings to discuss the approach and progress
	3k. Were theoretical explanations for the current organisational problem situation evaluated and reflected upon?	The literature review was presented to AirTrans
	3 L. Did the researcher reflect on the focal theory used and its ability to predict the change outcome?	We used OIPT as a cause-and-effect theory to enhance the fit between information processing requirements (reducing) and capacity (enhancing)
Change through action		
Principle 4	4a. Were both the researcher and client motivated to improve the situation?	There was a strong commitment of both the researchers and the client organisation to improve the situation
	4b. Were the problem and its hypothesized cause(s) specified as a result of the diagnosis?	A description of the *status quo* situation was part of the IQS
	4c. Were the planned actions designed to address the hypothesized cause(s)?	The solutions in the IQS were focused on the identified IQ issues
	4d. Did the client approve the planned actions before they were implemented?	The top management of AirTrans agreed upon the planned actions and facilitated the implementation

(Continues)

TABLE D1 (Continued)

	Criteria	AirTrans CAR project
	4 e. Was the organisation's situation assessed comprehensively both before and after the intervention?	We conducted a semi-structured interview to assess the situation both before and after the implementation of the planned actions
	4 f. Were the timing and nature of the actions taken clearly and completely documented?	A schedule was developed prior to the project and was monitored together with AirTrans
Learning through reflection		
Principle 5	5a. Did the researcher provide progress reports to the client?	Periodic meetings were held to discuss the progress of the project
	5b. Did both the researcher and the client reflect upon the outcomes of the project?	The research team and AirTrans together reflected upon the project and discussed recommendations for the future
	5c. Were the research activities and outcomes reported clearly and completely?	The research team shared a final research report with AirTrans, as well as the IQS business case
	5d. Were the results considered in terms of implications for further action in this situation?	The long-term solutions included in the IQS present further actions related to the DT of AirTrans
	5e. Were the results considered in terms of implications for action to be taken in related research domains?	Recommendations for future research were provided by the research team