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Roles, effects, and ramifications of in-person interactions in a digital team

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Abstract

The democratisation of Agile and SAFe development approach in the IT sector following the social web deployment in the second half of the 2000's led in parallel to the emergence of the digital transformation concept. In order to ease the collaboration and management on projects/programmes, particularly for those which involved several teams in different locations, a set of processes and tools to digitalize the way of working have been specifically developed.

Starting from the mid-2010s, the aerospace sector - especially New Space actors - initiated this digital transformation. But the COVID-19 crisis, besides the scientific challenge that the world needed to manage, forced all the aerospace industry to either engage and/or speed up their digital transformation. Overnight, organisations - public and private - had to quickly adapt their ways of working, implying for people involved a deep change in the way to manage their activities and their interaction with others. In this context, this study, conducted during the 2024 IPMC's Young Professionals Workshop organised by the IAF, aims to provide a framework to ease digital transformation deployment in the aerospace industry, from the early steps to the continuous improvement loops, also proposing recommendations to balance digital and in-person interactions.

After introducing the concept of digital transformation, the methodology of this study is presented. Its backbone consists in organising interviews to nearly 50 people with various experience and background. The data collected - dealing with the interviewees return on operational experience on digital transformation - have been then analysed in parallel to literature study. If it seems that today the digital transformation in the aerospace sector became a must to keep pace with technology development, it appears that the sudden digitalization particularly affected the balance between digital and in-person interaction. This statement is especially observed for the biggest organisations where inertia is generally larger, and where workers can feel lost and lonely by consistently digitally interacting with others.

Based on this analysis, a set of recommendations has been proposed, in order to help companies and organisations to deal with digital transformation, from its design to its post-deployment improvements. These recommendations highlight a strategy based on a step-by-step approach, using adaptability and resilience, underlining the importance of the mindset over the tools and - above all - keeping a dynamic way to interact between all.

Keywords: aerospace sector, project management, young professional, digital transformation, social interactions, workforce globalisation, Agile, Scaled Agile Framework, hybrid work, remote work, flexibility, meeting culture

Acronyms/Abbreviations

AOB	Any Other Business
Dev(Sec)Ops	Development (Security) Operations
DX	Digital Transformation
KISS	Keep It Simple and Straightforward
KPI	Key Performance Indicator
PA	Project/Programme Assurance
QA	Quality Assurance
REX	Return on operating EXperience
SAFe	Scaled Agile Framework

Tab. 1. List of Acronyms/Abbreviations

1. Introduction

The Agile methodology [1] was developed nearly 25 years ago, right after the global democratisation of the Internet during the 90s and where usage of more and more connected and digital tools exploded with Web 2.0 - the social web - deployment. The development of micro-services architecture, of virtualized environment, and tools allowing a better interconnection between people working on the same project led to a radical change in terms of development paradigm, firstly in the IT sector. But, if particularly fitted for small and co-located teams [2], the applicability of Agile for large-scale projects and programmes, often involving teams in different companies, organisations and - as a consequence - locations, is quite limited. For that reason, a scaled framework has been developed and standardised in the last 10 years: the Scaled Agile Framework (SAFe) [3][4].

Then, following the democratisation of these methodologies, another need emerged to ease the collaboration and management on projects/programmes, especially regarding those which involved several teams and/or companies/organisations in different locations: the need to digitalize the way of working. This need, called “Digital Transformation” (DX), became today a major player regarding the democratisation of the Agile and SAFe methodology [5][6]. It is in this context that tools like Jira, Confluence, Polarion, Planner (mainly) emerged. They allow nowadays to share a common requirements, features development and issues management system at project/programme level, associated with a better way of communicating between projects/programmes members with tools like Sharepoint, Teams, Zoom, Webex, and many others.

The overall concept of DX is quite simple to understand, as its main goal consists in adopting and implementing, generally at company/organisation level, digital technology in order to [7]:

1. **Enhance project/programme management**, by leveraging cutting-edge technologies to lighten the process and quickly adapt it to change if needed,
2. **Empower organisational culture**, by enabling seamless collaboration and flat hierarchy,
3. **Enable effective communication** between people involved, at all levels, internally and externally speaking.

The IT sector has been the first industrial sector to adopt DX. Concerning the aerospace sector, it has also been quickly adopted by the New Space actors in the 2010s’ [8]. Regarding the historical aerospace actors, a major event - even if at industrial level some actions have been already performed prior to it - forced them to deeply change their way of working into a more digitalized one: the COVID-19 pandemic in 2020.

Indeed, even if the DX engaged in the aerospace sector is actually a synergy of concauses, the pandemic era acted as a catalyst that pushed for DX of organisational processes and project tasks, in parallel to the need to attract and engage a globally distributed workforce. Like any other sector today, it is dealing with more and more delocalized teams, composed of people who are working together and often interacting solely through digital tools. This statement tends to be true both on an international scale but also for colocated teams - physically close to each other - and has inevitably affected professional and social interaction in the workplace [9][10].

More than four years after the beginning of the COVID-19 pandemic, this paper proposes to study the roles, effects and ramifications of in-person interactions in a digital team, and how this mode of working affects the execution of aerospace projects.

To study this effect of DX in the aerospace sector, the methodology used, described in the next section, includes the conduction of a survey answered by nearly 50 people in Europe, Middle East and Asia between April and July 2024, with various qualifications and work experience, and acting today in different positions. This survey aims to identify, using a diversified set of questions, the Return on operating EXperience (REX) regarding the deployment and usage of DX in their day-to-day duties.

Then, associated with a literature review providing a comprehensive overview of DX in the aerospace sector, the survey data have been analysed and a set of recommendations is proposed. These recommendations are later addressed to provide a framework aiming to facilitate the digitalization of the aerospace sector and allow continuous improvements of DX already done or still on-going at this time. In particular, the key role of

in-person interactions, and how to accommodate them in a digital team, is studied.

2. Methodology

2.1 Overall approach

The general methodology applied during this study is introduced in Fig. 1. The study was done after a comprehensive research and investigation on DX and its impact on industries in general and the aerospace sector in particular. This led to the set of five hypotheses which came to be the basis of the interview questionnaire created for collecting necessary data and to therefore accept or reject these hypotheses.

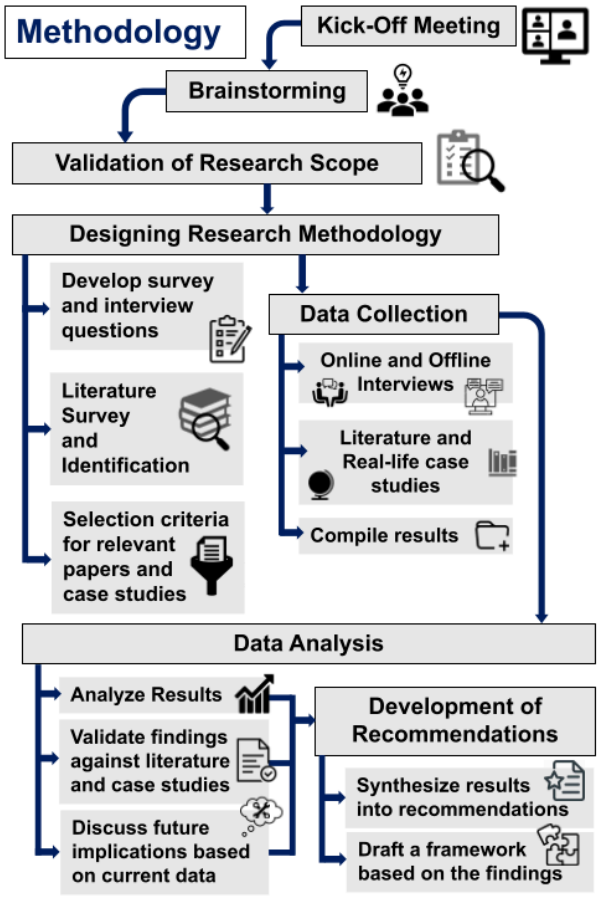

Fig. 1. Methodology applied for this study

2.2 Data collection process

As it can be seen in Fig. 1, the backbone of this study consists of the development of a survey and the conduct of interviews with people working in the aerospace sector. It focused on digital interaction and transformation, and their impacts on the day to day working practices of interviewees.

The survey was composed of 26 questions (not including four preliminary questions to identify the profile of the interviewee) dealing with five working hypotheses:

1. **Hypothesis 1**: Digital interaction enhances team productivity but may dilute team cohesion and interpersonal relationships,
2. **Hypothesis 2**: Successful negotiation of digital and in-person changes relies on tailored strategies that consider organisational culture, project scale, and team diversity,
3. **Hypothesis 3**: Best practices for managing digital and in-person interactions include clear communication protocols, regular check-ins, and collaborative tools,
4. **Hypothesis 4**: Tailored project management and training programmes that leverage digital and in-person elements can significantly improve team performance and adaptability,
5. **Hypothesis 5**: The digital transformation in the space industry will have lasting implications on workforce dynamics, requiring continuous adaptation and reevaluation of digital and in-person interaction strategies.

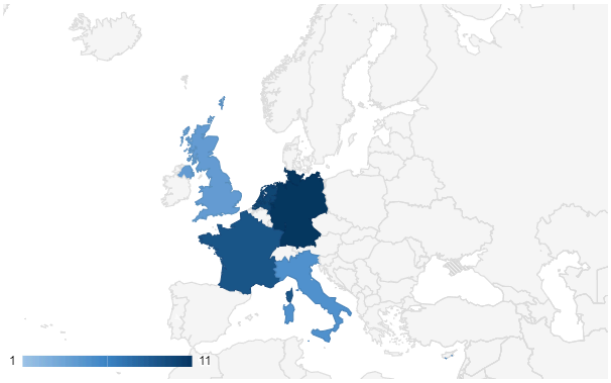

Fig. 2. Participants' location (Europe)

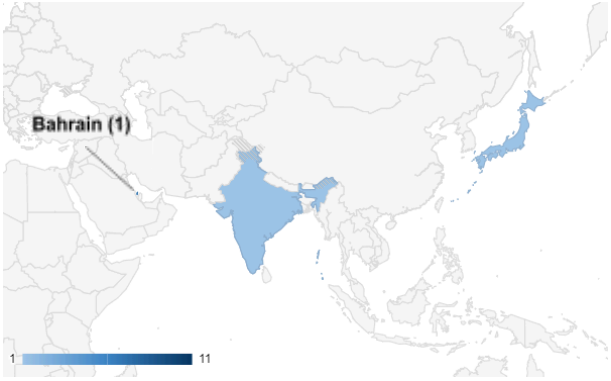

Fig. 3. Participants' location (Middle East & Asia)

The interview flow has been divided into four parts, not linked to a specified working hypothesis in order to avoid the creation of a bias into the answers:

1. **Digital Transformation and you**: this section focused on how people define DX and what are their main thoughts about it in terms of challenges. The confidence level about DX deployment is also studied here,
2. **Digital transformation in your current organisation/company**: this section asks the degree of deployment of DX in each interviewee's organisation/company, and questions the impact of this DX,
3. **Digital Transformation tools in your daily work**: this section deals with the usage of tools linked to digital interactions in the daily work life of the different interviewee, with a focus on digital/hybrid meetings,
4. **Your recommendations on digital transformation**: this section encouraged interviewees to give their own recommendations regarding digital tools, interactions and management, based on their own experience.

Of the 26 questions, 11 of them were open questions, inviting the interviewees to honestly answer the questions with their own words, in particular for questions related to their own experience with DX in their daily work life, especially concerning the meetings management and efficiency in a digitalized environment. 15 questions have been considered as closed questions, mainly regarding the recommendations that interviewees can give regarding strategies to conduct, the overall impact on DX in their life and their degree of knowledge and comfort about it.

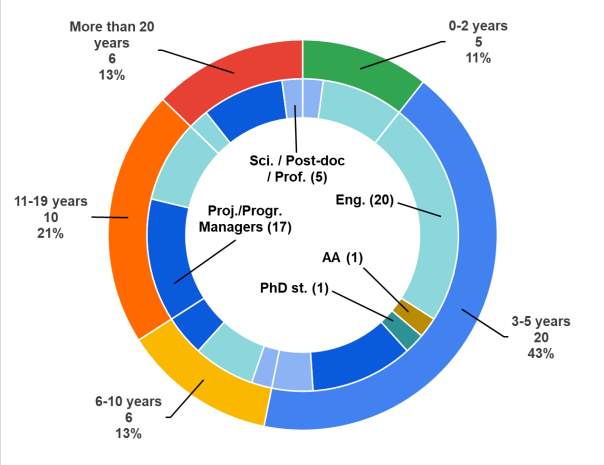

Fig. 4. Participants' years of experience and profile in the aerospace industry (AA = Administrative Assistant)

The data has been collected starting from the end of April 2024 (29/04/2024) to the beginning of July 2024 (07/07/2024). To increase the response rate and facilitate participation, each interviewee was offered the choice to either perform face-to-face interviews or to complete an online survey. In each case, the questions used were exactly the same.

47 responses have been collected from all around the world (Bahrain, France, Germany, India, Italy, Japan, The Netherlands and United Kingdom, see Fig. 2 & Fig. 3) and from a variety of profiles and experiences (administrative assistant, engineers, PhD students, project/programme managers, scientists, see Fig. 4) allowing a diversified data collection.

2.3 Post data collection process

Following this data collection, a detailed analysis has been performed, with a particular focus on the DX effects on in-person interactions. Then, with respect to a parallel literature study - a list of recommendations has been made aiming to facilitate the digitalization of the aerospace sector and allowing continuous improvements of DX already done or still on-going at this time. Specific recommendations related to the key role of in-person interaction in digital teams have been made.

3. Data Analysis

3.1 Cross-hypothesis data analysis

Alongside with questions related to the 5 working hypotheses mentioned in section 2 and on which detailed analysis is provided here after, some cross-hypothesis data analysis can be done on mainly two given topics:

- What are the first thoughts of each interviewee when the DX topic is introduced to them (see Fig. 5),
- The DX deployment level for project/programme on which each interviewee is currently involved (see Fig. 6).

If lots of thoughts have been exchanged with all the participants (see Fig. 5), 3 main topics have been highlighted:

1. **Necessity of modernization**: lots of interviewees underlined that the DX is today an excellent opportunity to update and modernise their way of working, including processes inside historical companies and organisations,
2. **Collaboration, sharing & transparency mindset**: it appears that most of the people interviewed linked the DX concept to

communication improvements inside project/programme, and to the accessibility of information,

3. **Be focused on efficiency, optimisation and flexibility**: last but not least, the main thought shared by the large majority of the participants deals with the concept of efficiency, optimisation and flexibility that DX can offer.

Fig. 5. DX tag cloud as per interviewees' thoughts

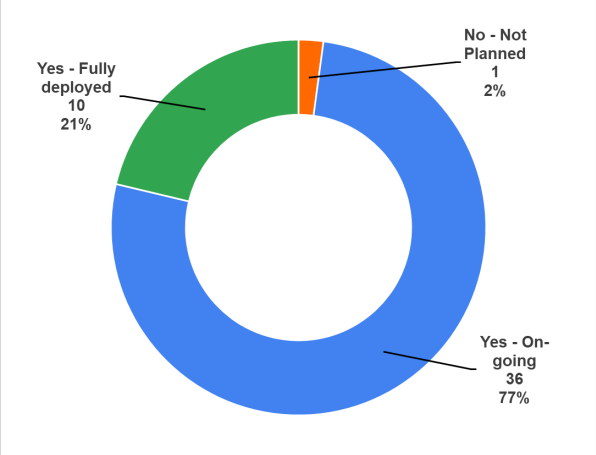

Fig. 6. Status of DX deployment

To sum up, it appears that most employees found comfort related to DX, blurring frontiers between on-site and remote working. Yet, besides these positive effects described above, the data collected also pointed an important counterpart: the need to adapt and to change, and concerning not only the tools, but also people's mindset.This may lead, as it will be detailed in the next sections, to some resistance and difficulties to change processes and adapt them to the modern challenges, especially ones New Space is bringing.

Concerning now the degree of deployment of DX, it seems that nearly all of the interviewees have experienced or are experiencing a DX (46 people out of 47, 36 of them experiencing an ongoing DX at this time), highlighting that this mindset change is now fully integrated into the aerospace sector.

3.2 Data analysis per working hypothesis

3.2.1 Hypothesis 1

"Digital interaction enhances team productivity but may dilute team cohesion and interpersonal relationship."

The impact of digital interaction on team productivity and cohesion, as well as the effects of remote work on these factors, have been extensively studied in the literature [11]. While digital interaction has the potential to enhance productivity through improved communication and sharing of information, it may also have unintended consequences such as diluting team cohesion and weakening interpersonal relationships. Factors such as reduced face-to-face interactions and reliance on technology for using digital tools can contribute to these challenges. In addition, comparing the findings from the aerospace sector to similar industries undergoing digital transformation, similarities in the overall patterns can be observed [11].

The role of digital interaction in enhancing team productivity is one of the key factors which was presented to the interviewees, who positively highlighted that two main effects of DX let the productivity improved:

1. Quick and easy access to shared data, leading to a reduction of miscommunications and clearer decision-making,
2. Increase of work efficiency, flexibility in work locations, reduction of stress levels and high collaborative teamwork.

On the other side, while team productivity is acknowledged to be significantly enhanced, the interviewees pointed out that there may be a slight dilution in terms of team cohesion. This is particularly important not only for achieving purely work-related objectives but also at social level. In fact, DX should not have a negative impact on interpersonal relationships. To avoid this, activities such as team-building activities and regular meetings (coordinated by team managers) should be considered of paramount importance. It shall emphasise the importance of finding a balance between digital and in-person interactions. This outcome is also confirmed by the literature [12].

The interviewees also highlighted that the effectiveness of digital interaction depends on the availability of suitable tools and on their proper utilisation. These challenges would be overcome by taking advantage of multiple training sessions, user manuals and definition of rules for a right use of the digital tools, as discussed

in details in section 3.2.4. Moreover, more than half of the interviewees emphasise the importance of having skilled digital experts in place in order to get prompt feedback on problems or doubts which may arise while using digital tools. The importance of tools - and their adapted configuration by experts - is further discussed in section 3.2.3.

But improper training and unfamiliarity with tools are not the only challenges that should be overcome. Indeed, according to the interviewees, aspects like misinterpretation, language barriers and facial expressions play a significant role in team dynamics. For this reason face-to-face meetings shall not be completely excluded: hybrid approaches which combine both digital and in-person interactions should be preferred. This point is further discussed in the next section.

3.2.2 Hypothesis 2

"Successful negotiation of digital and in-person changes relies on tailored strategies that consider organisational culture, project scale, and team diversity."

In order to derive the necessary strategies for the implementation of DX in companies and institutions, the interviewees were asked about their perceptions regarding the engagement of meeting participants and the general implementation of digital meetings. In particular, it was discussed which strategies are useful and recommended for the efficient implementation of DX regarding meetings.

When it comes to the commitment/engagement of meeting participants, nearly three quarter (74 %) of the interviewees highlight that digital meetings have a clear impact, meaning that the commitment/engagement differs from in-person meetings. Only people with less than 2 years of experience see - in majority - no difference in terms of engagement and commitment in meetings (see Fig. 7).

On the other hand, about 75% of the interviewees that did not see an impact on the engagement also did not recognize effects on the understanding of meeting participant's roles The interviewees with an experience level of 11-19 years solely name negative effects, in complete contrast to participants with more than 20 years of experience.

The main positive point that was highlighted by the different interviewees underlined the high flexibility in terms of collaboration that digital/hybrid meetings can bring On the other hand, the main negative effect that was mentioned concerned the risk of passivity within the meetings, driven by multitasking activities and a loss of focus on the ongoing discussions. Moreover, more than 80% of participants highlighted an issue related to the number of participants, whatever the types of meetings considered (physical/digital/hybrid). Indeed, usually, more people than needed are included in the meetings, and managing a greater number of attendees requires more effort. This could be solved by limiting the number of participants, and by sharing, through digital tools, the minutes to all people in a common platform, at a later time. Similar opinions on meetings can be found in the literature [13], leading to comparable recommendations as shown below.

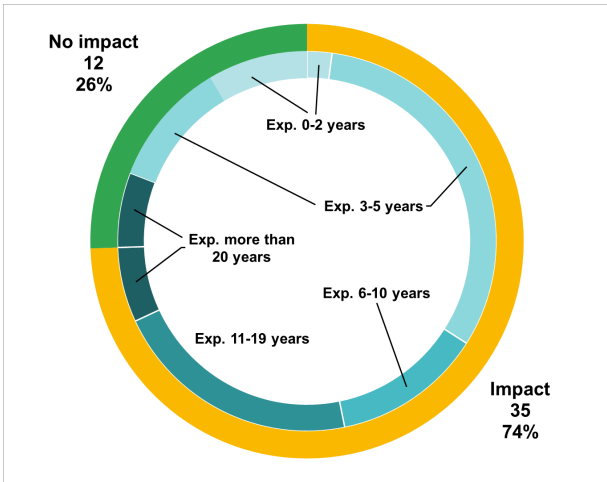

Fig. 7. Digital meetings impact on participants' commitment/engagement

Hybrid meetings seem somehow the most difficult meeting type and need some additional effort in comparison to fully digital or in-person meetings. The interviewees see the limitations of this meeting type mainly in the tools and communication/moderation of such meetings. The experiences and recommendations of the participants with regard to hybrid meetings correspond precisely with the literature [10].

Therefore, the interviewees see following skills/qualifications as very helpful when dealing with such meetings (ordered by frequency of mention):

1. **A good knowledge of the available tools and software** as well as a good general IT knowledge to proper use the given infrastructure. In addition, the deployment of a training plan for these given tools has also been underlined,
2. **Good communication, listening and moderation** skills are experienced as very important to properly manage these meetings. Thereby a proactive inclusion of remote

participants, whenever it is helpful/necessary, is important.
3. **Management skills** such as time management, patience, flexibility, and proactive problem solving are mentioned as helpful to overcome comprehension or technical problems.

Due to the globalisation of teams, efficient and purposeful hybrid meetings will become more and more important for project work. Thus, companies and organisations need to focus on improving hybrid meeting cultures. From the interviewees' point of view, companies and organisations mainly need to focus on:

1. **Shortening the list of attendees** by only inviting people that play an active role for the aim of the meeting,
2. **Being clear about the structure of the meeting** by communicating the topic, agenda and targets of the meeting in advance. Thereby, attendees can better prepare themselves,
3. **Making the meeting more interactive** by actively involving all attendees in the meeting.

These recommendations - also highlighted in literature [14] - are a consensus across all levels of experience.

3.2.3 Hypothesis 3

"Best practices for managing digital and in-person interactions include clear communication protocols, regular check-ins, and collaborative tools."

In today's rapidly evolving digital landscape in the aerospace sector, understanding the nuances of digital technology usage and its transformative potential within organisations is crucial. Both literature and interviews results indicate that as organisations increasingly rely on digital tools, understanding how these tools impact communication and work patterns becomes essential. For instance, [15] highlights significant shifts during the pandemic, such as changes in meeting structures, working hours, and communication methods, which have forced organisations to adapt to new digital realities. This aligns with the interview data finding, where most respondents are comfortable with digital tools, yet are facing some struggle with specific technologies, indicating a need for continuous adaptation and support.

DX is also fundamental for staying competitive, as noted by the participants. This is supported by literature [16], which examines the affordances and constraints of digital communication environments. Their analysis highlights the strategic value of carefully selecting and implementing digital communication tools to enhance workplace efficiency and social interaction. This literature reinforces the survey's emphasis on the importance of DX and the need for organisations to adopt technologies that not only improve operational efficiency but also support social and collaborative aspects of work.

Exploration of managing hybrid teams provides practical insights into how organisations can foster collaboration between on-site and remote workers [17] using tools. Literature also emphasises the necessity of formal online channels and supportive technology, which parallels the interviews finding that tools like SharePoint, Teams, and Slack are essential for integrated communication. However, [17] also points out the challenges of creating equitable experiences, which resonates with the 75% of respondents who see room for improvement in tools effectiveness. This highlights the importance of continuously refining, updating and monitoring digital tools to meet the evolving needs of hybrid work environments.

In addition, the challenges related to centralization, information management, and cybersecurity identified by some of the participants are also echoed in [15], which investigates how ease-of-use perceptions of communication technologies affect workplace relationships. Their findings suggest that when tools are not user-friendly, they can hinder communication and collaboration, especially in hybrid situations. This supports the interviewees study call for more robust and user-friendly digital solutions that enhance interoperability, integration and usability. These challenges suggest a potential misalignment between the tools and the specific needs of users, calling for a more tailored approach to tool selection and implementation. The lack of centralization and difficulties in tracking tasks and managing information have been also identified as major pain points. These issues can affect productivity and collaboration, particularly in an industry as complex as aerospace. Without an unified platform, teams often struggle to efficiently monitor progress and share critical updates, and access essential data.

Overall, while digital tools offer significant advantages by streamlining processes, enhancing efficiency, and facilitating collaboration among teams, they may also have limitations in terms of creativity and flexibility. For instance: such tools, like OneDrive (file-hosting service), may lack the customization options needed to tailor them to unique project needs or dynamic working styles, forcing teams to conform to the software rather than letting the software adapt to their needs. Another challenge is not just about preventing breaches regarding the data security and privacy but also about adhering to stringent data protection regulations that vary worldwide.

The general comfort underlined by the participants with digital tools and recognition of DX are positive signs. However, the identified challenges and mixed feedback on tool effectiveness highlight areas for improvement (see Fig. 8). Implementing the recommended best practices could address these issues and drive more effective and efficient use of digital technologies. Last but not least, it is worth noting that for DX to be successful, it requires the buy-in from everyone in the organisation. This process involves not only adopting new technologies but also - above all - embracing cultural and behavioural changes across the company.

To overcome the different issues identified above, some recommendations for best practices, identified not only by interviewees but also in literature [18][19] can be made. These best practices, from establishing clear guidelines and communications means to the deployment of flexible and resilient tooling platforms, are detailed in section 5.

3.2.4 Hypothesis 4

"Tailored project management and training programmes that leverage digital and in-person elements can significantly improve team performance and adaptability."

DX, by definition, is associated with new digital tools and new working methods [6]. Then, a clear design phase is needed, to build a tailored and customised DX, especially today where the number of digital tools is larger every day. But besides this design phase, a clear training programme must also be taken into account [9], in order to improve team performance and adaptability.

3.2.4.1 Training programmes

Continuous training and the introduction of new working methods can be implemented in various ways: either in-person or online, and either interactively (usually with a small number of participants) or lecture-based (usually with a large number of participants). As introduced in Fig. 9, more than half of the participants have been trained regarding DX deployment in their organisation.

All of those who have taken a training programme, whether it was mandatory or not, have reported an improvement in performance and adaptability to DX processes and tools. This shows the interest and usefulness of training, allowing people to understand the importance of the new mindset that DX brings, and to gain in terms of time to adapt to the new tools. Furthermore, it has been observed that people with more than 6 years of professional experience are more likely to follow a training programme (68%) than the people with less than 5 years of professional experience (40 %). This can be explained by two factors: prior training during their studies, and greater comfort with technologies in general.

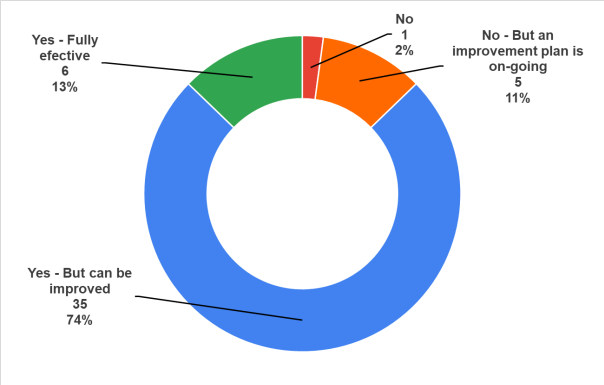

Fig. 8. Company/Organization's current digital tools and technologies effectiveness

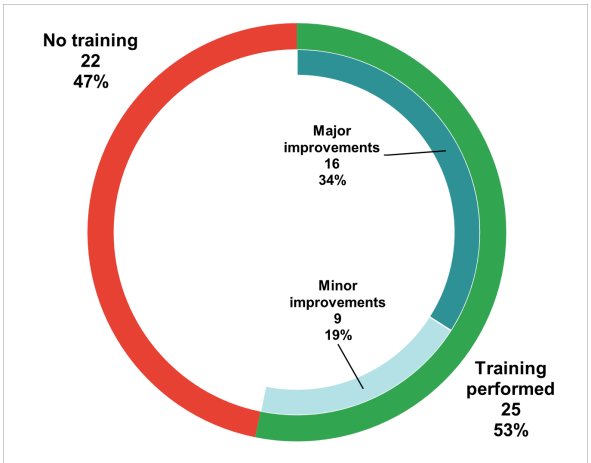

Fig. 9. DX related training and their impact on daily duties on survey participants

3.2.4.2 Project management

In order not to undermine the efficiency of a project/programme, a number of aspects have been identified as essential levers in DX: the mindset to adopt, the role of managers, the impact of meetings and the tools used [20]. Today, there is a profusion of digitals tools for communicating (Teams, Jabber, Slack, …), exchanging documents and storing data (OneDrive/Sharepoint, Drive, Confluence, …) and monitoring the different activities linked to a project/programme (Jira, Redmine, Polarion, …). Yet, as underlined by the majority of the interviewees, the main difficulty lies in the fact that these tools are often too numerous and generally poorly chosen and/or

configured. Furthermore, it appears that it is not common for newcomers to follow a dedicated training regarding their usage. Consequently, it is important to first design the new processes and requirements then choose the tools. Using this method, the tools will serve the processes, and the most appropriate ones could be chosen.

Moreover, the respondents also noted that the deployment of a limited number of tools, and also avoiding too complex processes, is very helpful. Indeed, with a smaller amount of tools - and designed/deployed in a way that their role/function is clearly defined - the redundancy aspects that can be sometimes seen in activities follow-up and reporting can be reduced, and even avoided. Besides, the interoperability and collaborative nature of the chosen tools is essential, in order to interconnect information between them.

Complementary to statements made in section 3.2.2 on digital and hybrid meetings, it has been highlighted by the participants that it is also important to think about the best way to communicate. Indeed, in a digital environment, communication is key, including all levels of management, engineering and procurement. People want to be heard, and holding feedback sessions where all team members can share their insights and challenges is seen as a clear benefit to identify issues early and adapt strategies to overcome them. It has also been underlined, by the interviewees and by the literature [18][21], that a continuous improvement process must be put in place, based as much as possible on real-time feedback from all people involved. Last but not least, project and programme managers have a central role, by assessing these feedbacks to better adapt the processes. DX can also help them to set clear objectives to empower the different team members and strengthen their confidence, by adding some trust and flexibility into the processes.

3.2.5 Hypothesis 5

"The digital transformation in the space industry will have lasting implications on workforce dynamics, requiring continuous adaptation and reevaluation of digital and in-person interaction strategies."

As introduced in sub-section 3.1 (see Fig. 6), one major difficulty often associated with DX according to this study is the need for people to change and to adapt to new tools, new processes and - above all - new mindset. This could indeed lead to some resistance, and has been highlighted by almost 40% of the interviewees.
Yet, this difficulty raised during the study does not seem to interfere at all with the overall confidence level people have on DX on two major topics:

- Easing information sharing inside and between teams at project/programme level (Fig. 10),
- Changing the way to manage the different activities, modernising and lightening the processes (see Fig. 11).

As it can be seen in Fig. 10 and Fig. 11, there is not so much disparity of confidence level regarding both topics, even if the overall degree of confidence regarding the information sharing is a little lower.

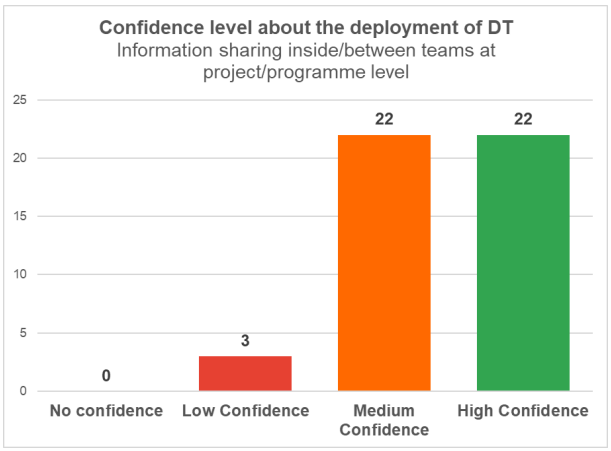

Fig. 10. Confidence level about the deployment of DX (information sharing)

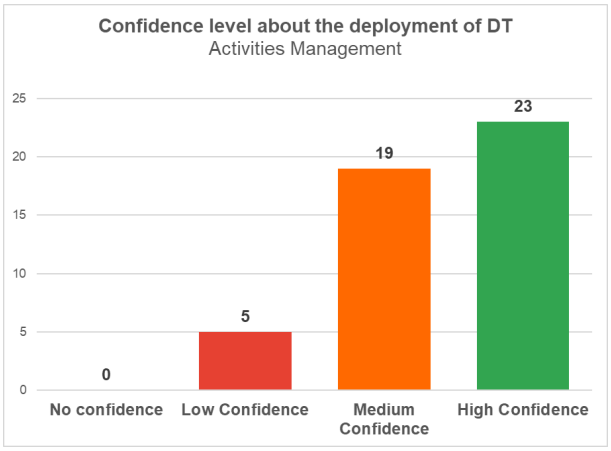

Fig. 11. Confidence level about the deployment of DX (activities management)

Regarding the information sharing topic, only 3 people over 47 get low confidence on this part, where 44 show medium or high confidence. It also appears from the data collected that the confidence level is higher for non-manager positions, for which people seem more inclined to centralise all information regarding a given project/programme, easing information sharing and helping a lot with the silos breaking effect coming with Agile/SAFe methodology. This statement is also aligned with what can be found in the literature, regarding the

centralization of information, on which all studies highlight its huge positive impact, also at management level [21].

Concerning activities management, the confidence level remains high. While more people show low confidence compared to information sharing (5 against 3), 89% report medium or high confidence. Most of them agree that digital tools improve management efficiency, by also automating KPI production. Participants noted that DX has made collaboration easier and task management clearer, though it demands full involvement. This aligns with literature emphasising improved collaboration and task follow-up as key benefits of DX deployment [22].

Last but not least, those with low confidence in information sharing tend to also show low confidence in activities management. Yet, the low confidence in DX seems not linked to participant experience, as those with lower confidence come from various experience levels and positions (from administrative assistants to project managers). In addition, over 65% of participants agreed that working in a digital environment improves both individual and team work (see Fig. 12), underlining that DX facilitates information sharing and helps individuals to track and to organise their tasks. Some interviewees also highlighted that DX aims to improve teamwork, particularly for large projects involving teams in different locations.

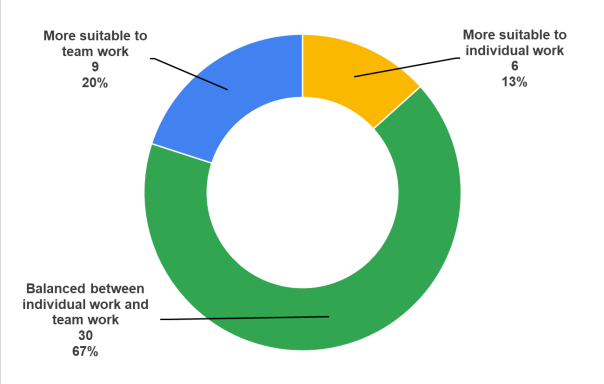

Fig. 12. Digital Transformation and way of working

Most interviewees agreed that DX improved traceability, allowing parallel work on documents with real-time updates, which boosts efficiency, reduces redundant work, and saves time for technical tasks. Some also noted that DX promotes adaptability and flexibility, emphasising the need for collaboration to ensure a smooth transition. However, about 40% of participants mentioned negative impacts and risks associated with DX, alongside its positive effects on centralization and transparency of activities.

The top risk identified is linked to the multiplication of online meetings, reducing participants' engagement and meetings' inherent efficiency and the overall productivity of project/programme. This specific topic has already been discussed in detail in section 3.2.2 above. Another side effect associated with DX introduced by the participants is the risk to reduce the commitment of people in the project/programme by fully dealing with a digital environment. This can lead not only in reducing at strictly minimum the physical interaction, but also in taking the risk to spend more time managing digital tools than performing the activities themselves.

Whatever the risks raised above, they seem directly linked to the same core issue: the deployment of an unadapted DX, that can lead to additional work during the different phases of the project/programme (mostly phase B/C/D - Preliminary Definition / Detailed Definition / Qualification & Production), and lost of tools efficiency [18][20]. This issue, generally linked to a wrong preparation of the DX deployment, and the possible solutions, are discussed in the next section.

4. Results Highlights & Discussion

The first highlights that can be made concerns the high degree of transformation of the whole aerospace industry. This underlines - as per literature statement [21] - that DX is today recognized as a lever to remain competitive and to keep in tune with the times.

From the five initial assumptions that have been made, it appears that the impact of DX on in-person interactions and - in general - in the way of performing day-to-day duties, could not be negligible. Indeed, in the light of the interviews results analysis, a list of main statements regarding DX can be easily made, highlighting the positive and negative impacts, and the challenge associated with DX.

4.1 DX positive impacts

The core positive impact highlighted by all the participants is about the huge improvements brought by DX in terms of information sharing between all people involved in the same project/programme, enhancing - and encouraging - collaboration between everyone. This statement is not really surprising, as the transparency is the essence of DX itself [22]. Complementary to this, the general improvement of project/programme management has also been underlined. By using a common set of tools available to everyone, the ability to schedule and manage all activities related to a project/programme increases the confidence level and motivation that people can have on their work. DX

appears to help a lot to smooth the different processes, easing the identification of issues and their resolution, and reducing the time spent on logistical issues. Last but not least, if the first goal of the DX is to increase the information sharing and collaboration among coworkers, a significant side positive effect has also been mentioned by the participants: the ability to increase their day-to-day duties efficiency thanks to DX.

Another positive point that needs to be underlined concerns the initially expected generational gap. From the interviewees' answers, it appears that the technical challenge that DX could bring is not related to the experience level of the different participants. The ramp up phase related to DX processes and tools seems really independent from people's age and experience, and the comfort with respect to digital tools and recognition of DX's importance is today generalised.

Last but not least, it seems that each participant, whatever their positions (managers, engineers, professors, students, administrative students, …) tends to see the full potential behind DX, as well as the importance of keeping team cohesion as strong as possible in a digital/hybrid world. This statement can also be found in several other past reviews [5][7][18].

4.2 DX negative impacts

Regarding the negative impacts that DX can bring, literature [7][14][23] and interview data analysis highlights that the use of digital tools can introduce an important bias in terms of digital/in-person interactions balance. Indeed, the high-intensity usage of digital tools can sometimes lead to a slight dilution not only in terms of people's involvement into the project/programme, but also in terms of team cohesion in general. More particularly, people's commitment and engagement have been impacted by the digitalization of meeting, both in terms of passivity that can be brought and also in terms of blurring people's roles. Communication among people in virtual meetings can also be affected because facial expressions, gestures, and hand movements are missing. In addition, the aerospace projects/programmes globalisation, associated with the democratisation of home working, led also to the generalisation of hybrid meetings. This kind of meeting appears to bring additional challenges, as it seems that they are creating a kind of disparity between people that are physically interacting and people connected online. This results - still today - in a kind of lack of trust in both digital and hybrid meetings, as they are perceived less efficient and sometimes not fully usable, as one of the DX side effects is their multiplication. This statement, already raised in the literature [13], also points out that nowadays, digital/hybrid meetings often suffer from missing clear agendas and multitasking participants.

Another general concern that can be extracted from the interviews data is related to the training part associated with DX. Indeed, nearly half of the people interviewed shared that they did not receive a specific training regarding new tools and new processes that they have to use now. On the other hand, people who have been trained recognized that they experienced improvements in their day-to-day duties management. This highlights the importance of training, as well as the set up of a DX plan prior to its deployment (also underlined in [5] and [18]). Therefore, it appears important to have the same level of training among the involved people to avoid any inefficiencies and misunderstanding.

4.3 DX challenges

For the majority of the interviewees, the top challenge is to deploy an adapted DX that clearly responds to a real need. The idea here is then to have a clear strategy, defined prior to any DX deployment at company/organisation and/or project/programme level. This design phase should involve all people, in order to collect all the needs in terms of processes and propose an implementation plan on which all can agree. In addition, it is also important to mention that DX - by design [21] - is also about the ability to quickly adapt to change, being able to update a process when necessary. This also needs to be taken into account in advance during the development of the deployment plan, by including some flexibility into the processes and tools.

Another challenge - directly correlated to the previous ones - concerns the tools associated with DX. Today, the diversity of tools can offer tailored digital solutions, but it quickly raises the question about the interoperability between them. Indeed, to be fully efficient, the different tools must be connected and information that is stored on them must be fully aligned to avoid any miscommunication. This is even more challenging when several companies and/or organisations are involved in the same project/programme, as the tools involved may not be the same - even if they aim to satisfy the same goals. In this situation, some adjustments - that need to be well designed prior to the project/programme kick off - seems to be necessary.

Then, linked to negative impacts on digital/hybrid meetings mentioned above, the study participant's underlined that the need to maintain a good team cohesion in a digital world constitutes a challenge by itself. Indeed, there seems to be a consensus - not only from the interviewees' data analysis but also from the literature [15][17] - that even in a digitalized world, the

interaction between people must remain important. This means that in-person interactions still have an important role to play, as well as promoting direct interactions during digital and hybrid meetings for people connected online.

Finally, people also underline that training sessions are at some point necessary, especially regarding the new processes that are put in place. The challenge behind this is to consider several training sessions, at the different steps of DX deployment and also for different positions, as already mentioned in some studies [17][20].

5. Recommendations

Considering the interviews' outcomes, it becomes clear that a successful DX implementation requires more than simply picking some tools and deciding to implement them. From the experiences and feedback underlined by all the participants and from the literature review, a list of recommendations can be made, to emphasise the positive impacts, reduce the negative ones and address the challenges that need to be solved.

These recommendations are organised around five major topics, also introduced in Fig. 13:

1. **Keep it simple**,
2. **Mindset over tools**,
3. **Step by step approach**,
4. **Adaptability and resilience**,
5. **Balancing digital and in-person interactions**.

5.1 Keep it simple

The first key recommendation is to keep things simple. This principle is already well known in the engineering world, as the KISS (Keep It Simple and Straightforward) principle [24]. In the context of DX, it consists in thinking of an overall simplification of the different processes, taking the DX as an opportunity to modernise them and building them on best practices that emerge not only at organisation/company level but also from outside [25]. The idea behind this last statement is to base DX on real-world and successful cases, avoiding reinventing the wheel that in most cases will lead to more complex solutions.

In particular, this recommendation proposes to:

- **Uniformize processes between teams**: managers, PA/QA (Product/Programme Assurance and Quality Assurance) & engineers from the same or different teams should share and be embedded in the same processes, avoiding their multiplication that can become easily and quickly not manageable,
- **Minimise the number of tools**: to avoid useless complexity and gain time in terms of management and training,
- **Break the silos**: simplification is also about providing to all people involved on the same project/programme the same amount of information.

This last statement is particularly important because it also allows people to be more integrated into the project/programme, and feel less lonely, by sharing to everyone a common status for all activities linked to the project. For teams and/or people that are not physically present in the same working area, the silos breaking effect that DX can bring is really a game changer, but also requires a major change of mindset.

Fig. 13. Main recommendations

5.2 Mindset over tools

The development of Agile/SAFe methodology also brings an important principle that needs to be considered in any DX: the importance of mindset over the tools. The mindset to apply in this situation is directly inherited from one of the four Agile values [1][4], derived from the original manifesto: "individuals and interactions over processes and tools". This highlights the importance of giving more value to people than to processes and tools. This recommendation is quite easy to understand, as people respond to business and technical needs, managing their development. If the processes or tools start to drive the development, the team becomes less responsive to change and less likely to meet the needs.

In real life cases, applying such mindset consists in:

- **Enabling seamless collaboration and flat hierarchy**: encourage cross team interactions, based on the "breaking silos" strategy, instead of using classic hierarchical interactions. Direct interactions between people will also allow them to gain confidence in their role inside the

project/programme and feel more integrated, increasing their capacities to manage their activities by themself,

- **Enabling effective communications**: communication must be as fluid as possible and driven by individuals, instead of processes. If not, the communication becomes scheduled and loses its impact.

At management level, it also implies to trust the people more, and let them gain independence not only to manage their activity, but also to share their outcomes to everyone at the same time, aligned with the open communication mindset that DX has to bring.

5.3 Step-by-step approach

As mentioned in section 4, one of the challenges that has been highlighted by the participants is about the need for a well tailored DX design and approach. In parallel, DX - as introduced above and especially for big projects/programmes - has to be considered as a big change in terms of mindset, processes and tools. In this context, a step-by-step approach should be considered for any DX, as already recommended in the existing literature [5][21]. This approach can be separated in 4 different phases:

1. **Establish a clear digital strategy and vision**: it aims to catch the needs of all people involved and what they expect in terms of change. It is important here that all people's thoughts can be taken into account and studied, as it will allow the design of a tailored DX. It is also during this phase that the processes and tools are chosen, in line with the KISS principle. It should also align with the company/organisation's overall goals and adapt to technological advancements,
2. **Pre-deployment training and continuous learning**: in order to allow a smooth transition, people - whatever their position and role - must be trained prior to DX deployment. The pre-deployment training session can also provide precious feedback to better identify future implications of the changes made.
3. **Step-by-step deployment**: like the overall approach, the DX deployment by itself should follow a step-by-step approach, processes by processes and tools by tools. It aims at having actionable steps to offer a better adaptability to the different teams,
4. **Introduce feedback loops for continuous re-evaluation and improvement**: implement feedback mechanisms that allow teams to continuously assess and refine digital tools and processes. The main purpose behind this is to be able to identify areas for improvement in real-time and quickly adapt to successful changes implemented by other agencies/industries.

The first step can represent a challenge by itself, as depending on the size of the project/programme, the need capture has to be performed in a completely different way. For biggest projects and programmes, an escalated approach is often chosen, splitting the need definition into smaller groups, and then discussed at DX board level by some representatives. This DX board must be composed of people that already have strong experience in DX, but also with people that have a strong knowledge on the previous processes to better shape the new ones.

5.4 Adaptability and resilience

From the three first topics, a challenge that needs to be solved appears: to make any DX successful, people involved have to believe in it. To minimise the risk of deploying something that people will not find useful, the step-by-step approach recommended above is of course essential, but it is also important to involve open minded and resilient people. In general, as interviews data analysis has shown, the aerospace sector is more likely to accept changes that DX brings, and even encourage them. Yet, as in all sectors, it is important that people that will have to deal with the new processes and tools can be involved and feel welcome from the very early step of DX. Thanks to this, a better adaptation, as well as a better trust, to this new digital way of working can be enabled.

Adaptability and resilience can be then seen as a key to be able to apply to everyone the right mindset associated with DX. This can also help a lot to quickly adapt to changes involved by continuous re-evaluation and improvements. Lastly, people's engagement on their day-to-day duties can be improved if they contribute to these changes. Indeed, even if one of DX's negative impacts is the decrease of in-person interactions in general, letting the people to be involved in their DX could increase their confidence in a digitalized workplace [15].

5.5 Find a balance between digital and in-person interaction

As already mentioned, the role of DX is not to erase the physical and social interactions, but to offer solutions to better manage projects/programmes, proposing more efficient processes through adapted and modern tools. Yet, it is clear that working in a too digitally oriented environment can strengthen people's loneliness,

especially in this post-COVID period, where digital solutions to interact are today largely preferred. In addition, the number of attendees in digital meetings tends to increase a lot, naturally reducing the sense of usefulness of such meetings and of people involved in general [17]. If hybrid meetings seem to be a very good compromise between fully digitalized and fully in-person meetings, it appears that people following the meeting online could not generally interact correctly with others [15]. Last but not least, even if the use of digital tools to correctly track activities' status is today largely standardised, some important information related to them are often discussed in-person in the workplace, increasing the feeling of exclusion of people working from remote or from other places.

Here again, based on interviewees' answers and literature [9][19][23], a set of recommendations, tailored to reinforce interactions in both digital and hybrid meetings, can be made:

1. **Reduce the number of attendees to the minimum need**,
2. **Define a clear and structured agenda prior to each meeting (and follow it)**,
3. **Make sure that all attendees can interact, exchange their thoughts and agree with decisions made**,
4. **Focus on the meeting** and not parallelize meeting participation with other activities.

To summarise, the idea is to apply the same guidelines to digital and hybrid meetings than any in-person meetings. If it seems quite obvious, it appears that these kinds of best practices rules are not always applied today. In this context, a proper knowledge transfer on meeting culture has to be considered. Last but not least, good communications and moderation skills are a key to enthuse colleagues with new interactivity means.

Besides this, in-person interactions can also be reinforced by digital means. If today chat technology became a standard to quickly exchange with colleagues, a direct call can offer a limited in-person interaction experience and have a good impact on their well-being. Last but not least, it is important that all information - even those quickly exchanged in-person - can be correctly tracked using agreed processes and tools.

6. Conclusions

Digital Transformation (DX) is not merely a trend, it represents a fundamental shift in how organisations operate, interact with customers, and approach their business models. As highlighted in this study, DX is characterised by the integration of digital technology into all areas of a company/organisation, fundamentally changing how they deliver value.

In this context, the five initial hypotheses established at the beginning of this study allows a better understanding of interviewees thoughts and findings about DX. Supported by a literature review, it appears clearly that if DX deployment represents a challenge by itself, it can efficiently support a complete reinforcement of collaboration between all people involved in a project/programme. Using dedicated and tailored processes and tools, information can be quickly shared and exchanged in a transparent way. This also can be applied to most technical parts of such projects/programmes, such as source code or test results, that can be quickly accessible by everyone, allowing an automated way to produce KPI to better identify risks.

On the other hand, it also clearly appears that DX can bring some counter negative effects, essentially linked to the inherent reduction of in-person interaction. Indeed, in the digital era, team members can literally work on different continents, which entails the major risk of loneliness of workers, especially in the post-COVID era. If the effect on the general well-being of team members is obvious, it can also have important effects on the project/programme management. Slowly, people involved in digital and/or hybrid meetings can feel less needed, lowering their involvement and their will to share information, as well as blurring their roles, and also those of other people.

From the different interviews conducted in this study, it seems that most of these negative effects can be easily explained by the way the DX has been deployed. In some situations, the digital tools deployment has been rushed, only focusing on not so well tailored tools and not enough on mindset and processes. In addition, a lack of dedicated training, associated with a too large set of tools, complicates the adaptability to DX and project management.

In light of this, a set of several recommendations could be made to minimise the risks and ensure a reliable DX. The right way to go with DX is complex and multifaceted: organisations must navigate the interplay between technology, culture, and human dynamics to realise the full potential behind it. As businesses embrace this transformative journey, aerospace agencies also must prioritise adaptability, collaboration, and data-driven decision-making. By doing so, they will not only enhance operational efficiency but also create a more engaged workforce and improved employee experiences. Ultimately, the successful implementation of DX strategies will pave the way for a more Agile, responsive, and sustainable future in the business landscape. In particular, regarding in-person interactions

in a digital world, a complete change of paradigm must be considered, by always pushing for more direct interactions and collaboration, even through digital means.

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