6-18-2022

HYBRID USE OF AUTOMATION AND AUGMENTATION IN INTRODUCING AI APPLICATIONS FOR ARTISTIC GYMNASTICS

Elena Mazurova
Aalto Business School, elena.mazurova@aalto.fi

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Research Paper

Elena Mazurova, Aalto University School of Business, Helsinki, Finland
elena.mazurova@aalto.fi

Abstract

Discussing a recent piece by Raisch and Krakowski, the paper compares their postulates with results from studying an AI-powered system's implementation for judging artistic gymnastics. The empirical study extended beyond the organisational context discussed by Raisch and Krakowski, to consider the various stakeholders' perceptions of the new system's role as a support or a substitute system. Observations reveal that the obstacles to automation of the sport's judging process may coalesce around the system's cognitive limitations. Additionally, an automation-oriented approach could bring negative social and economic consequences for the judges. The obstacles to augmentation, on the other hand, are largely related to biases of both humans and AI-based systems. Hence, potential exists for implementing a hybrid approach that can mitigate the negative consequences of both and that might represent beneficial social and economic implications for this field of sports.

Keywords: Article review, AI, Hybrid automation–augmentation approach, Case study, Sport.

1 Introduction

The introduction of AI-powered systems in pursuit of greater efficiency, productivity, and reliability of processes is gaining momentum in various fields. One field thus influenced by intelligent systems is high-profile sports, where recently Fujitsu introduced a new AI-powered electronic judging system for artistic gymnastics. Applying 3D sensing technology, it captures a multi-angle view of the gymnast's movements during the routine, after which AI technology analyses these and provides a final score.[1] The system is intended to increase the accuracy, objectivity, and speed of the judging process at big international competitions.

Because of the rapid and intense development of intelligent algorithms, the role of AI in computers' work alongside human experts is starting to display increased variety. Now, besides serving as a tool supporting humans' physical and cognitive capabilities, AI-powered systems may even overcome some problems bundled with human capabilities and come to replace humans in various kinds of task execution. Therefore, new AI-based systems bring with them the question of which approach to implementation is better: automation or augmentation. Whereas augmentation implies humans' active involvement in the process, exchange of skills and knowledge, and mutual learning between humans and AI-based systems, the primary goal with automation is delegation of humans' tasks to systems and keeping humans out of the processes (Brynjolfsson and McAfee, 2014; Daugherty and Wilson, 2018; Davenport and Kirby, 2016).

[1] Fujitsu's judging system is described at https://www.fujitsu.com/global/about/resources/news/press-releases/2018/1120-01.html.

Researchers' views on the advantages and disadvantages of automation and augmentation are divided, with some giving preference to augmentation, for facilitating good performance, while others recommend automation, for its efficiency gains and related advantages. There is a third camp, however. In a recent paper, Raisch and Krakowski assert that automation and augmentation processes are 'interdependent' and cannot be 'neatly separated' (2021: 193). Their article makes them among the first to claim that the automation- and augmentation-based approaches to AI implementation should be considered through the lens of paradoxes, with awareness that the two ways of carrying it out are complementary and in ebb and flow with one another. In their opinion, an orientation solely toward either automation or augmentation ends up focusing largely on contradictions. Thus ignoring the two's interconnections can create paradoxical tensions in the management context and lead to negative consequences both for organisations and more broadly. In contrast, a paradox-tuned lens enables accounting for their interdependencies, and an approach that draws together these two ways of applying AI can deliver benefits and positive consequences for the organisation and even society at large.

Motivated by the recent surge in research interest directed toward paradoxical tensions involved in AI-enabled system implementations, in this review essay we respond to Raisch and Krakowski's paper. Taking the recent paper as a starting point, we conducted inductive qualitative research and a cross-comparison of the authors' statements about various AI applications[2] and results from our empirical study. We aimed at, firstly, identifying how well the alternative theoretical frameworks suggested by Raisch and Krakowski mesh with the real world by means of a case-study application of an existing construct to a specific industry; and secondly, extending the authors' work beyond the management context, to considering AI applications in the context of competitive sports.

Prior socio-technical research highlights the importance of a consideration of potentially contradictory viewpoints of the stakeholders (Sarker et al., 2019) as most studies of AI applications are conducted in 'laboratory settings' and 'disregard the role of humans, and the wider […] societal implications' (Raisch and Krakowski, 2021). However, careful consideration of the stakeholders' viewpoints might result in successful tailoring and integrating of the technological changes to the social component of the organization and increase the autonomy, completeness, well-being, and job satisfaction of the workers (Sarker et al., 2019). Therefore, in our work, we focus on studying the role of AI systems as support or substitute from the various stakeholders' perspectives. Accordingly, we asked: '*What is the various stakeholders' view on AI-enabled system's applications in artistic gymnastics?'* To tackle that research question, we interviewed various international stakeholders in artistic gymnastics to gain a holistic understanding of their perceptions of AI applications and the nascent Fujitsu system in particular.

We proceed as follows. In Section 2, we discuss the various approaches to using AI-powered systems, automation/augmentation/hybrid approaches in specific fields. In the third section, we outline our methodology. The fourth section presents the findings from the empirical study, and the remaining sections offer discussions.

2 Literature Review

The introduction of AI-system-based technologies in organizations' operations raises the question of which approach is best for their implementation and which form of human-AI cooperation should be established. The debate about the role of AI in its co-operative work with human experts has received the bulk of the attention in recent academic discussions. The remainder of this section is devoted to discussing the literature on various approaches in greater depth.

[2] In this paper, the term "AI applications" is used in the meaning of various approaches to the implementation of AI systems, as it was discussed by Raisch and Krakowski and interpreted by the author.

2.1 Peculiarities of automation

Automation of the processes and AI systems' ability to substitute for humans is of great interest to researchers in IS studies and draws attention to many questions. Automation implies that AI systems take over the dominant role in the execution of the tasks, becoming the main actors (Campolo et al., 2017). Implementation for tasks that require a systematic approach can be realised well by means of automation in various domains, such as accounting, health care, marketing, law, and hospitality applications (Crawford et al., 2016; Lindebaum et al., 2020). Human workers may relinquish some of their daily routine tasks to systems, thus speeding up and increasing the efficiency of the information-processing and decision-making. Subsequently, systems might replace a portion of the labour force in these tasks (Russell and Norvig, 2009; Wilson et al., 2019). An automation-focused approach displays such advantages as enhancing productivity, driving costs down, expediting the processes and establishing faster information-processing, and overcoming human cognitive limitations by means of AI systems. However, some researchers claim that fully automating processes and using AI as a substitute system is impossible in the execution of some tasks requiring human interaction, creativity, a 'sense of beauty', and social interaction. After all, AI-based systems still lack certain vital human features, such as creativity, artistry, inventiveness, motivation, and capacity for human empathy (Plastino and Purdy, 2018).

Experts have not reached consensus on the implications of automation and intelligent systems' deployment with regard to the future. Some insist that automation and the introduction of AI-based systems will benefit society overall, increase productivity, propel economic growth, and create more jobs in the emerging field of maintaining the systems (Davenport and Ronanki, 2018; Plastino and Purdy, 2018). Others, in contrast, predict that many workers will face harm from the automation of labour in the coming decades (Agrawal et al., 2017; Wilson et al., 2019). Over time, focusing on automation could lead to extensive job losses and to unemployment and social inequality rising further (Brynjolfsson and McAfee, 2014: 171). Experts in this camp argue that, while automation may lead to new jobs, these will be either undesirable, low-paying ones or system-support-related jobs that require advanced qualifications and do not suit those who have lost their job in the wake of automation (Wilson et al., 2019). Some studies suggest that even an AI system initially designed to empower workers may ultimately exert the opposite effect and encourage unfair labour practices (Crawford et al., 2016). Among the additional adverse effects of automation that might hit workers are partial employment, decreased work quality, and problems related to social and financial instability (Davenport and Ronanki, 2018). Together, these diverse risks associated with automation could highly destabilise workers' situation. They might lose the required professional skills, be uncertain as to their financial stability and professional perspective, experience insufficient social protection, and find themselves unable to plan their career or life in general (Campolo et al., 2017; Crawford et al., 2016). It seems that, while automation and the implementation of intelligent algorithms in organisations' practices can increase the processes' efficiency, accuracy, and speed, the consequences that ensue for the human workers meanwhile may be negative and irreversible.

2.2 Peculiarities of augmentation

The second approach, augmentation, is defined as the interaction between humans and AI-based systems in executing tasks and making decisions that neither sort of agent could handle efficiently enough on its own. Under this approach, the humans and AI systems continuously interact with each other actively to reach superior efficiency, productivity, and speed. Here, humans learn from machines, and machines learn from humans, with the continuous mutual learning and knowledge exchange enabling improvements to both human and machine capabilities and skills (Daugherty and Wilson, 2018; Davenport and Kirby, 2016). Co-operation between humans and AI systems in the processing and provision of complex solutions enables exploiting each other's strengths and compensating for the other party's shortcomings. In cases of their successful introduction, AI systems can, through their superior technical capabilities, process information, execute tasks in high volume, and provide 'real-time' decisions and evaluation at a pace that might be too fast for humans (Campolo et al., 2017). Humans, in turn, can complement the AI in some cognitive tasks, define and set the goals, and exercise corresponding control of the overall decision-making. The appropriate extent of human involvement varies with the specific task at the given point in time (Russell and Norvig, 2009). Some authors state that in their co-operation humans and AI systems may sometimes become so closely aligned with each other and 'think', work, or process information together in such an efficient manner that it might even be difficult to draw a line between their functions sometimes (Brynjolfsson and McAfee, 2017). Therefore, human–AI collaboration could be of great value for improving and facilitating an evaluation process and affording faster, more efficient, and highly accurate decision-making.

Notwithstanding the advantages of an augmentation-oriented approach, some issues remain in relation to its concrete implementation in organisations. Firstly, on account of the active participation of humans in the decision-making process, the augmentation's outcomes are not always reliable or consistent (Huang et al., 2012). While augmentation affords overcoming a machine's limitations via humans' intuition and other attributes, at the same time human biases and subjectivity can sometimes carry over to machines and influence their decision-making (Brynjolfsson and McAfee, 2014: 92). Secondly, augmentation requires a special strategy and measures for building solid co-operation between humans and machines (Daugherty and Wilson, 2018; Davenport and Kirby, 2016: 201). The organisation must guarantee extensive enough resources, including the financing necessary for establishing integration and knowledge exchange between human and machine agents (Raisch and Krakowski, 2021). Insufficiency of resources often combines with augmentation's complexity and associated uncertainty to produce failure, and subsequent efforts to reinforce the augmentation might lead to even bigger failures and losses (Amershi et al., 2014).

2.3 Hybrid approaches

In terms of a joint operation of human and AI agents, there are several perspectives. Some researchers, such as Rai et al. (2019), suggest focusing on human-AI hybrids. They state that different variations of human-AI hybrids (e.g., tasks' substitution, augmentation, and assemblages) might enable more effective task execution and better integration of the AI agents' technical capabilities with the cognitive capabilities of human agents. Human–AI-hybrid-type cooperation might help to overcome such problems as emerging algorithmic biases or various human biases being carried over to the machines, transparency-lacking black-boxed decision-making processes, and limitations to the systems' cognitive capabilities.

Others consider a pair of AI applications: automation and augmentation. However, there is no agreement among them on which AI application is better to use. Researchers who favour augmentation portray it as a path to superior performance, on account of efficient co-operation between humans and machines (Daugherty and Wilson, 2018; Davenport and Kirby, 2016), while those recommending automation cite driving cost-related efficiencies, better organisation-level performance, and faster information-processing (Agrawal et al., 2017; Crawford et al., 2016). The former implies humans' active involvement in the process, with exchange of skills and knowledge between humans and AI systems, while the primary goal for automation is 'to keep humans out', removing them from the process of executing the tasks (Gillespie, 2014). At first glance, the two approaches appear contradictory. Both yield specific advantages and disadvantages, and each requires the introduction of measures distinct from and conflicting with those applied for the other. The two may well evoke opposite stakeholder perceptions, and, as noted above, the choice between them hinges on the tasks and situation at hand at the given point in time. In addition, the tension stemming from this decision may well lead to negative-reinforcement cycles and trigger unintended consequences for the organisation and society (Raisch and Krakowski, 2021).

In contrast, Raisch and Krakowski in their work claim that a line cannot be drawn between automation and augmentation. The authors characterise these AI applications as 'dual' and interdependent processes. They state that one-sided orientations 'toward either automation or augmentation [...] neglect the dynamic interdependencies between AI's dual applications' (2021: 200) and can lead to incorrect and incomplete managerial solutions that reinforce the tension rather than resolve it. The authors state that the choice of pure automation or augmentation works for only a relatively limited time and a specific task.

Considering the impact of automation and augmentation for multitasking in the long term spotlights how interdependent these two approaches are in several key respects: Firstly, a constant process of mutual learning and sharing of knowledge between humans and AI agents is vital, and this does not stop once the system has been introduced. Also, success demands human experts' constant revision and control of the AI system's decision-making, which might incorporate algorithmic biases and errors. Because those problems may recur or emerge at any stage in machine-learning activities, this process should not be restricted to only the first stages of the system's implementation. Thirdly, as prior research shows, augmentation may give way to automation or *vice versa*. For example, humans who are part of an augmentation-oriented process may ultimately delegate their work entirely to the system, once a significant amount of the experts' knowledge has been transferred to the machine. Likewise, automation can lead to balanced human–system interaction in processes' latter stages as the new knowledge accumulated by the machine-learning process becomes useful for humans (Raisch and Krakowski, 2021).

In consequence of the above-mentioned aspects, close interaction between humans and AI systems takes place in various phases in technologies' implementation, and these players constantly influence one another along the journey. Their tight coupling renders it increasingly difficult to disentangle the two seemingly pure applications of AI. They are 'no longer separate, but are mutually enabling and constituent of one another' (Raisch and Krakowski, 2021: 193). Hence, organisations that account for not only the contradictions between automation and augmentation but also their interdependencies and that apply a strategy combining the two can cultivate virtuous cycles of benefits for their operations and society as a whole, according to the authors. Among the diverse benefits that automation and augmentation's combination can create for an organisation are creation of complementary returns, provision of superior firm performance, incremental enhancement to both human and machine capabilities, reduction in the digital transition's negative effects on employees, and a gradual shift toward more creative and fulfilling tasks.

3 Methodology

In response to the exploratory nature of our research and its focus on human perception of technological changes, we chose to conduct an inductive qualitative case study following grounded-theory methodology (Charmaz and Belgrave, 2012; Wiesche et al., 2017).

3.1 Case selection and collection of data

To select the empirical setting and informants, we employed purposeful sampling (Patton, 1990). Our choice of the field of artistic gymnastics, in turn, was due to it being subject to implementation of a novel AI-powered electronic judging system. The intent is for this system, in the event of successful development and implementation, to enter use later in other Olympic sports. The system's developers chose artistic gymnastics as the pilot field because of its complexity and the clarity of its Code of Points (CoP) rules.[3]

As for the participants in our study, we interviewed stakeholders of artistic gymnastics who have an international level of qualification and who are going to be directly affected by the AI-powered system's implementation. These individuals have deep understanding and many years' experience of participating in international competitions in this field and hence can provide their expert opinion on

[3] The CoP rulebook is at http://www.codeofpoints.com/mens-gymnastics/

perspectives and potential roles connected with a new electronic system in the judging process. We conducted semi-structured interviews with 21 informants, thereby involving five gymnasts, 10 judges, two coaches, two technical directors in artistic gymnastics, one representative of the International Federation of Gymnastics (FIG), and one representative of Fujitsu as the company developing the new system. The interviewees are characterized in Table 1.

Role	Pseudonyms
Gymnast	James, John, David, Thomas, Mark
Director	Steven, Mary
Coach	Paul, Kevin
Judge	Abby, Bella, Charlie, Edward, Harry, Lilly, Nick, Norman, Sarah, Ulla
Fujitsu	Caleb
FIG	Simon

Table 1. The interviewees.

The interviews employed open questions designed to facilitate discussion with the informants on the various topics related to the research question and to encourage them to share their opinions. All interviews were tape-recorded and transcribed. The responses were anonymised, and our reporting here uses pseudonyms for the participants.

The paper by Raisch and Krakowski was chosen as a backdrop for our examination because of its unique approach addressing the paradoxical nature of automation and augmentation, its relative novelty, and recommendation of a new method that combines the two.

3.2 Data analysis

We conducted analysis of all interview material by using software designed for qualitative data analysis (ATLAS.ti). The empirical data were analysed via three coding techniques, in line with grounded theory: 1) open coding, 2) axial coding, and 3) selective coding. With the open coding we were able to conduct initial analyses of the data and identify the common ideas, patterns, and opinions among the participants with regard to AI-system implementation in artistic gymnastics. We ended up with 96 distinct codes. Secondly, to identify the relationships between distinct groups of interviewees (gymnasts, judges, coaches, etc.) and common opinions and perceptions among them as to the system introduction, we used axial coding. Identification of the similarities and patterns was performed across groups as well as within them. The second stage of coding resulted in 17 codes, of various sorts, reflecting common patterns within and among the groups of interviewees. Finally, we applied selective coding for both our data and the material in Raisch and Krakowski's paper. We coded the statements made in the text to group them into a set of automation, augmentation, and a hybrid approach; then, these were subcategorized addressing the respective approach's 'prerequisites' or 'obstacles'. This afforded the analysis that followed, examining our empirical results alongside the authors' statements. The comparative analysis of the paper and our findings involved cross-reading and identification of correspondence and patterns between the authors' statements and the findings from our empirical study. Proceeding from this analysis, we were able to identify and then summarise the participants' perceptions of the role of the AI-powered system in the judging process in artistic gymnastics, and corresponding prerequisites or obstacles related to each AI application. Due to page limitations in this paper, we provide only a selective the most interesting findings from our empirical work corresponding with the three individual approaches presented in the studied paper.

4 Findings

According to Raisch and Krakowski but also other researchers, automation and augmentation each typically exhibit certain prerequisites and present certain obstacles to implementation. In our empirical study, we found several intersections between these authors' comments on automation, augmentation, and hybrid approaches to AI in organisational context, on one hand, and the claims of our interviewees about AI-powered judging systems' use in artistic gymnastics, on the other. From the voluminous interview data, we have selected the most comprehensive, interesting, and valuable material to accompany the discussion below.

The presentation of our findings proceeds as follows: Firstly, we describe prerequisites and obstacles related to implementation that were identified for automation, augmentation, and finally a hybrid approach. Each peculiarity then is framed via Raisch and Krakowski's discussion, supplemented by our reasoning. After this, we present statements from our interviewees that resonate with these.

4.1. Obstacles related to automation

4.1.1 'A one-sided focus on automation could cause extensive job losses'

Raisch and Krakowski, p. 201: '[A] one-sided focus on automation could cause extensive job losses and result in the deskilling of managers who relinquish tasks to machines, which could lead to the further risks of rising unemployment and social inequality.'

However impressive the results of AI may be in increasing processes' efficiency, accuracy, and speed, the effects of these advanced automated systems on employment in various fields may be even more disruptive. Many AI-powered systems may achieve efficiency and significantly lower costs at least partly by replacing human workers. Job losses wrought via a one-sided focus on automation may not be limited to the corporate world. Judges who participated in our research expressed the fear that, via its advanced technical capabilities, the new judging system could lead to a reduction in the number of judges involved with international competitions and subsequently to wholesale replacement of the human judges..

Of course, you should understand that some of the atmosphere among the international judges is fear, and laughing. Is it the case that in the future we won't be needed? Some people are totally against this system now. They think that it's not gonna work, it's not good. But I understand that we can't be against it. I know that if you have enough data, you can teach the computer to give the score etc. And the system could be perfect – it would see all these angles and turns and jumps better than human eyes can see. But if it is coming, this system could replace at least some of the judges, and this part of the judging is actually we human beings. We can be against it, but it will come anyway. And it is coming even more quickly than we think, so we can't deny it. But [...] I would want personally to continue judging and not be replaced by some […] robot. (Felicity, judge)

4.1.2 'Human experts […] lose their specific skills'

Raisch and Krakowski, p. 199: 'Over time, these organizations lose the human skills required to alter their processes […]. Human experts are either made redundant through automation or they lose their specific skills regarding the tasks they no longer pursue.'

Gradually, automation might end up exerting negative effects on workers' skills in organisations that opt for automation, causing the human experts' skills to deteriorate. For reasons associated with automation-related technological changes, human experts might lose motivation to do their job at the same level as before so may let their professional qualifications lapse or erode. Hence, organisations or, in our case, an entire field of sports may lose qualified experts. Many of our informants had spent several decades with this sport and achieved considerable status as highly qualified international judges. They stated that they might lose professional skills and their special qualifications because of the system's introduction.

Why should I be a judge if I can't do judging anymore? If they're gonna use this Fujitsu system at the international level, I will not be able to do my work anymore. And if I can't be a judge anymore here at the international competitions, I will stop doing all the work in my [local] federation, which is clear. And I'm doing really important work in my federation. I'm running the judges' courses, helping the athletes, consulting people. In the education of the gymnasts also, there's a very big part for judges. I'm one of the main judges in my country. But if I'm not a main judge anymore, I will go away. (Lilly, judge)

4.1.3 'Machines do not possess human senses, perceptions, emotions, and social skills'

Raisch and Krakowski, pp. 198–199: '[M]achines do not possess human senses, perceptions, emotions, and social skills […]. [AI] agents are very limited in their capabilities, because fundamental technical and ethical challenges limit their potential for human-level emotional sentience in the foreseeable future.'

Since systems – agents based on AI in particular – do not possess creativity and humanity, it seems unlikely for it to become possible to automate processes in fields that demand a uniquely human sense of beauty and the ability to evaluate creativity. Artistic gymnastics is precisely such a field. Here, both technical and artistic components of athletes' routines get evaluated. According to the interviewees, since the nature of artistry and our understanding of it are bound up with human emotion and preferences, an AI-based system is incapable of evaluating it.

It's not only about the artistry but also about the visual perception, the amplitude of movement, or the height of the jump. We also take into account the height and the size of the gymnast. Taller gymnasts achieve a more beautiful performance, but shorter gymnasts do better technically [...]. And at different apparatus, their achievements also vary. At the parallel bars, for example, if a small athlete comes out, she has less leverage so the amplitude will be less and shorter, and another athlete is much taller, so, correspondingly, her amplitude will be greater. Also, at the vault, take a short athlete, for example: for her height, she pushed as much as possible and flew off to the maximum. The distance for her body is normal, but visually it seems that she landed too close. And the other athlete is tall. She jumped powerfully, flew far away, got up beautifully. Visually, these are two big differences. But if, in fact, we take the ratio of the parameters of one gymnast to another's, then the quality and the technique of their performance is somewhere at the same level. For a short gymnast, we know where her boundaries are, where she can land. And if she landed a little further out, then it's generally cool! But if it's a little closer, then it's clear that she lacks strength, power, etc. This is why the scores can vary [...]. And sometimes when the spectators watch a tall athlete, they think, 'Wow, how cool her jump was! This is power!' And when they watch a small one, 'Whoa! And why did they give her such scores?' They don't see and don't understand these nuances. An AI system also will not understand. (Ulla, judge)

4.1.4 'Machines cannot fully capture ambiguous predictors, such as cultural fit or interpersonal relations'

Raisch and Krakowski, p. 198: 'Machines cannot fully capture ambiguous predictors, such as cultural fit or interpersonal relations, for which there are simply no codified data available.'

This statement articulates machines' inability to capture certain vital predictors. There are many fields in which people are used to a sense of human interaction or the feeling of involvement and human empathy. Transitioning to an automated system might bring a negative experience of lacking these inherent human features. For example, our informants in artistic gymnastics claimed that human interaction between the judges and gymnasts, of judges with coaches and gymnasts, and with fans is an important part of the competitions that give the gymnasts a feeling of confidence, motivation, and excitement, helping them perform well.

I'm not quite sure how the athletes will feel. Because I think that when an athlete does a good exercise and looks over to present to the judge and sees the reaction of the judge, I think that's something that is a human emotion that gives that athlete a good feeling […]. Or when it's not so good and the judge *has a sympathetic look even though the routine was not good, maybe the athlete still knows that there's someone who is cheering about the performance. You always look at the judges, right? So, the judges react to everything, and the gymnasts sometimes also react in turn. And if you're not making sure you have enough energy to do something and judges cheering you on, it can give you adrenaline and you can successfully do something. Well, I'm not sure if artificial intelligence will be able to provide that type of feedback to the athlete. A human factor. (Charlie, judge)*

4.1.5 'The use of AI [may] have implications for social equality and fairness'

Raisch and Krakowski, p. 202: '[T]he use of AI in management could also have implications for social equality and fairness. Automation takes humans "out of the loop," reducing human biases and, in turn, promising greater equality and fairness […]. However, real-world applications show that machine biases caused by noisy data, statistical errors, or socially vexed predictors often lead to new, even more systematic discrimination.'

On one side, automation of the decision-making process can help to reduce the human biases that always exist in areas where human experts are involved, but, on the other side, the implementation of AI systems might induce new biases related to algorithmic errors and prejudices of the developers in-built in the systems. Aware of the coming AI's possible biases, our interviewees articulated their concerns related to usage of the new electronic system in artistic gymnastics and its possible consequences for gymnastics.

The system can be, really, as good as the people who are creating the software for the systems. There's always going to be maybe a chance of a system error because the error was made in programming the system. Therefore, I trust any software as much as the person who has programmed it. I mean we all know instances of software that intentionally had malicious code put into it. So it depends on what's going on with the creators of the software. (Charlie, judge)

4.2 Prerequisites and obstacles related to augmentation

4.2.1 'The intense interaction […] increases the risk of human biases being carried over to machines'

Raisch and Krakowski, p. 202: '[A]ugmentation is likely to reduce […] machine biases through human back-testing and feedback. However, the intense interaction between managers and machines increases the risk of human biases being carried over to machines. This problem is particularly pernicious, since machines then confirm humans' biased intuition, which makes humans even less likely to question their preconceived positions.'

While augmentation may well reduce biases in machines through such feedback mechanisms, close interaction between humans and machines elevates the risk that human biases are going to carry over to the machines' work. It has become clear already that systems' biases can indeed become an obstacle not only to AI's use in automation but also to augmentation. In close co-operation between AI-based systems and humans, when biases get transmitted to machines, the human biases are, in turn, reinforced. Our data show that, in artistic gymnastics, judges' biases and prejudices are considered a big issue for gymnasts, and any biases emerging – or merely seeming to appear – may become an even bigger challenge once an AI-powered system comes into play.

People are emotional. And we're under the influence of emotions even when we evaluate the technical part of the routine. For example, right now we had the vault, and there was one athlete we argued about later on because our scores varied [...]. I liked her. In my very subjective opinion, she jumped very well – she reached her maximum – so I gave a good score. But another judge […] did not like her and the score was way lower [...]. [W]e have such discrepancies in our scores [...], maybe not discrepancies but just differences in opinion. For example, a result score of 9.233 means that one judge bet 9.4, another judge bet 9.3, and someone else bet 9.3 [...], and this 'four' [0.4] turned into 0.33 in the result. (Ulla, judge)

4.2.2 'Humans learn from machines and machines learn from humans'

Raisch and Krakowski, p. 195: 'Augmentation is therefore a coevolutionary process during which humans learn from machines and machines learn from humans […]. In this iterative process, managers and machines interact to learn new rules or create models and improve them over time.'

The hallmark of augmentation is mutual learning and sharing of knowledge between human and AI agents. This enables enhancing both humans' and AI agents' skills and qualifications, deepens their interaction and co-operation, and provides additional benefits that aid in improving organisations' tasks and processes. With regard to artistic gymnastics rather than corporate operations, our participants admitted that they have much to learn from AI-based systems in areas such as gaining higher accuracy, but they were aware also that these systems have to learn from humans – for example, about humanity.

I think a combination could work. I mean if we work together [...]. Computers are always more accurate than people, than humans are. We can learn from [computers] – what they have to do, what they can do, what the criteria are [...]. We've learned from them, and maybe a computer can also learn from us? (Nick, judge)

4.2.3 'Some organizational actors prefer augmentation […] while others prioritize automation'

Raisch and Krakowski, p. 195: 'The tension is further reinforced because some organizational actors prefer augmentation (e.g., managers at risk of losing their jobs to automation) while others prioritize automation (e.g., owners interested in efficiencies).'

Divergence in preferences is another factor that exacerbates the tension. It seems that those who benefit more from automation support that approach while others, who may see in it some disadvantages while augmentation could yield greater benefits for them, might well prefer the latter. In our case study, some stakeholders were very negative in their comments about automated judging systems; however, not everybody agreed that automation is an 'evil'. The advantages of an AI-powered judging system and the benefits it could bring to the judging process for artistic gymnastics seem to hold so much promise that several interviewees expressed confidence that the current panel of judges can be entirely replaced by such an electronic system.

I'm in pretty full support [of the idea] that the panel of judges [will end up] replaced by AI. I don't see any problems with it. I think that would be certainly possible and very fair. And I would be very open to all of the judges being replaced, and I think that's super-doable. (David, gymnast).

It's impossible! Simply impossible! I see this system only as support for judges, as a very effective supportive tool. But replacement of human judges? No, impossible, never. (Harry, judge)

4.3 Prerequisites related to a hybrid of automation and augmentation

4.3.1 'Automation and augmentation jointly generate outcomes that neither application can enable individually'

Raisch and Krakowski, p. 200: 'Organizations can purposefully iterate between distinct automation and augmentation tasks, allowing long-term engagement with both forces […]. The two AI approaches' juxtaposition stimulates learning and fosters adaptability, allowing the combination of (machine) rationality and (human) intuition, which enables more comprehensive information processing and better decisions […]. Through integration, automation and augmentation jointly generate outcomes that neither application can enable individually.'

In their paper, Raisch, and Krakowski state that an organisation starting off with AI automation can subsequently switch to augmentation or *vice versa*. This transition and a combination of the two 'pure' approaches in AI implementation can help bring AI-based systems' advantages in conjunction with humans' strengths. Some interviewees stated that a hybrid automation–augmentation approach could possibly offer advantages for artistic gymnastics. They also stated that automating some aspects of judging may sufficiently benefit all stakeholders while an element of human involvement and control over the automated system is still needed.

Speaking in general about using the technology, I think that combination could be a good thing. I think it helps the judges. If it's using the measure[ment] things, I think that in some aspects this system could help the judges because we're humans and when we're trying to determine angles and degrees of split and completion of the turn, the human eye can't see so much for these things. I mean it could be similar to [how] they use [the] line in football or tennis. Because on the floor and for the vault the mats sometimes move a little bit, so if you could put sensors in and sensors could pick [out] whether someone's foot went over the line or not, then that would be fairer than using human eyes. So using this system can be good. Also, I think it is very useful in helping to determine whether [a] deduction should be [made] or not, to make sure that the gymnasts get a fair score. The system could be used for angles – for example, to say 'yes, that was completed within 10 degrees; you should not [apply a] deduction' or 'it was past 10 degrees; yes, you should deduct'. That's helpful. And I think that most judges want the best and right scores for the gymnasts. We think we see accurately now but could see better. For instance, if it was an obvious error, I think you can see it almost always, but if it was something doubtful [...], then maybe I would trust the machine because it would be more precise. For example, I['ve] experienced that usually with [a] split the gymnasts do more than what I will see, and with turn[s] usually the gymnasts do a little bit [more] than what you actually see. And any experienced judge knows this. So if I thought I had seen [a] 180-degrees split and the machine was telling me that was 90, I would trust myself, but if I had seen 180 and the machine showed 190, I would say 'yes, I believe that'. (Abby, judge)

4.3.2 'Humans [must] retain overall responsibility'

Raisch and Krakowski, p. 200: 'Integration [of automation and augmentation] therefore requires humans to retain overall responsibility for a managerial process. Prior studies have shown that maintaining overall human responsibility not only reduces human bias […] but also prevents human–machine collaboration biases.'

The involvement of human experts and their co-operation with automated systems not only enable guaranteeing that the machines are kept under control and checked but also help the human experts themselves to overcome some possible problems and prejudices related to the intelligent systems' implementation and also to mitigate the issues that the process of digital transition may create for them. Our study revealed some resistance and negative perceptions of a potential AI-powered judging system on the part of some key stakeholders, notwithstanding their awareness of its benefits. Therefore, their deep involvement and overall responsibility for the system's work could afford more positive perceptions of the proposed system and smoother incorporation of it into the humans' work.

I think that it has to be someone always there backing the system up. Because, of course, there can be some black boxes and some problems with the system, and it's new and you can't fully rely on it. If it's used at, for example, the world championship, it has to be secure. In the future, there will be just a few people who are the head judges and then the computers working things out, and if there's a problem then humans can be responsible for that. (Thomas, gymnast)

The way forward could well be a hybrid approach that integrates automation and augmentation.

4.3.3 'Rather than being adversaries, humans and machines should combine their complementary strengths'

Raisch and Krakowski, p. 193: 'Rather than being adversaries, humans and machines should combine their complementary strengths, enabling mutual learning and multiplying their capabilities. Instead of fearing automation and its effects on the labor market, managers should acknowledge that AI has the potential to augment, rather than replace, humans in managerial tasks.'

Humans and machines demonstrate complementary strengths. In light of this, intensive involvement, active integration, and close co-operation between human and AI agents are needed to yield benefits from what both offer. The following statement by one interviewee perfectly meshes with the scholars' foregoing comments on this crucial matter:

We should take all the benefits of it. Not as an enemy. We should take it as help for the judges. In those moments when it's so difficult for the human eye to see something, that machine should help us, so we should combine it [with what we do]. For me, that's the best solution. (Felicity, judge)

5 Discussion

In line with the initial aims, our case study produced several contributions and outcomes on several fronts: considering the theoretically oriented statements made about the two overall approaches to AI applications in light of the empirical study; extending the work by Raisch and Krakowski beyond the management context, to considering AI applications in the context of competitive sports; uncovering paradoxical tension related to the implementation of AI; examining AI's implications, by means of the perceptions multiple stakeholders exhibited, from a socio-technical perspective; and shedding light on the changing role of AI in co-operation of machines with human experts in organizations' practices.

Firstly, our study shed light on the paradoxical tension accompanying AI-enabled systems' various applications. Comparing Raisch and Krakowski's statements on the paradoxical and interdependent nature of the two 'pure' approaches to applying AI with our empirical findings as to the stakeholders' views on the role of AI in judging artistic gymnastics, we were able to observe that the two approaches manifest an interdependent and paradoxical nature. On the one side automation requires augmentation in some cases. For example, some participants opined that the purely human judging process requires automated evaluation systems, to increase its quality, accuracy, and objectivity. However, at the same time automation might pose various challenges in the evaluation process (e.g., the inability to capture 'cultural fit' or 'interpersonal relations' or to 'possess human senses, perceptions, emotions, and social skills') and bring negative social and economic consequences (such as 'extensive job losses' for the judges, loss of professional skills for the human experts, and 'implications for social equality and fairness'). What is interesting is that many of these challenges, according to the stakeholders, could be resolved via the involvement of human experts – in other words, by augmentation. On the other side, similar concerns arise with augmentation: increasing the mutual learning and knowledge-sharing between humans and machines, might lead to an increased 'risk of human biases being carried over to machines' due to their intense interaction, which is absent in automation scenarios. Applied individually, each of the approaches, automation or augmentation, creates challenges that can be mitigated by the other and lack the advantages provided by the alternative approach. This demonstrates their interdependency.

Secondly, from a socio-technical perspective, our empirical results have revealed a large gap between the theory and practice of introducing AI applications. Prior research highlights the importance of the adoption of the technological changes to the social component of the system and consideration of various stakeholders' viewpoints (Sarker et al., 2019). However, our findings attest that, despite generally positive perceptions of an AI-based electronic judging system in artistic gymnastics, the key stakeholders experienced fear in the face of the proposed system's advanced capabilities while also being concerned about its technical limitations. Firstly, its advanced capabilities and the potential for automation of the artistic-gymnastics judging process had led many judges to fear losing their job and being replaced by an electronic system. They expressed concern about lost jobs, privileges, and social status in relation to the introduction of the new judging system. Therefore, stakeholders demonstrate negative perceptions and non-acceptance of this advanced technology. Secondly, interviewees stated also that such a system is not qualified enough to handle judging independently, without human interaction. They pointed to the system's inability to cover some crucial features of the judging process in artistic gymnastics, such as evaluation of artistry and provision of the level of human interaction that gymnasts are accustomed to at the competitions. Additionally, they expressed concerns about the possibility of technical errors and system failures during international competitions, which could have a negative impact on all key stakeholders, fans included. Overall, informants predicted that the overall quality of artistic gymnastics will dramatically decrease if AI comes to dominate the judging process. Thus, our findings of the tensions and contradictions among the various stakeholder groups with regard to the introduction of AI for judging in artistic gymnastics highlight a need for exercising careful control of the impact that deployment of AI-based systems may have on the social aspect of organizations. Involving the key stakeholders more intensively in the process of such systems' implementation, and increasing their awareness of the relevant AI system's technical capabilities and its role in future evaluation processes will enable the 'collaborative optimization, fit and harmony' of social and technical elements (Sarker et al., 2019, p. 704).

Finally, the stakeholder perceptions of the contradictions and tensions related to the AI system point to a clear need for a hybrid approach to AI applications, as identified in prior works (Rai et al., 2019; Raisch and Krakowski, 2021). Such hybrid human-AI interaction should involve alternation of augmentation and automation: spans of human experts' plus AI's co-operative work, then autonomous work by the AI agent. In this alternation, the main role of an AI-based system is clearly to fill a supportive function rather than replace human experts; the system executes tasks for which its technological capabilities exceed human ones, while overall responsibility remains with humans (Raisch and Krakowski, 2021). A hybrid human-AI approach might enable the best of both worlds: obtaining the distinct benefits of each approach, finding a solution to the problems created by using either augmentation or automation alone and reducing the digital transition's negative effects on stakeholders (Rai et al., 2019). For example, a hybrid approach could help to mitigate biases that appear in decision processes; align the capabilities of AI agents (e.g., speed, accuracy, reliability, and impartiality) with the competencies of human agents (e.g., creativity, empathy, and humanity); and enable human experts to train the AI agents to some extent in artistry, human interaction, moral values and compliance with good ethics, etc. Rather than being adversaries (Raisch and Krakowski, 2021), AI and humans are brought together to function as an integrated unit and augment one another, for the successful and efficient performance of the task (Rai et al., 2019).

Limitations and further research

The horizon for future work is promising. As most empirical studies are, ours is not without its limitations. In this work, we have presented only those statements by Raisch and Krakowski that correspond with our empirical study. Further research should undertake a more comprehensive, broad-based, and deep consideration of inconsistencies and anomalies that deviate from frameworks established by Raisch and Krakowski. Also, just as their discussion concentrates on the field of management, our study was strongly focused on AI-enabled systems' implementation in another specific context: gymnastics. Further research could probe stakeholders' perceptions of the role of AI in multiple fields simultaneously. Besides, future research could also examine AI systems at various stages of development and explore such vital related matters as the issues that arise as hybrid approaches' development becomes reality.

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