AMBIDEXTERITY AS THE RESPONSE OF SMART INDUSTRY 4.0 – TOWARDS BETTER HR PRACTICES

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ABSTRACT

Due to the global labor market challenges, international companies react and adjust fast to these circumstances by implementing digital solutions into all business processes. Organizational ambidexterity is seen as the response of digital transformation and it can be divided into structural, contextual, and sequential dimensions. In this context, organizations representing the smart industry will need employees with specific competencies which let them meet technological challenges.

This chapter aims to clarify the state of opinion on expectations towards, and preparedness for, the impact of Industry 4.0 on human resources management and the implementation of various types of ambidexterity in these companies. We have conducted interviews with key HR informants from manufacturing companies operating in Germany and Poland. We have found that Industry 4.0 has a significant impact on HR practices. In both international companies, various digital solutions in employee recruitment, development, and performance, have been implemented. There have also been mature examples in both companies of structural, contextual, and sequential ambidexterity.

Keywords: Ambidexterity; smart industry; HR management; digitalization; HR challenges; Industry 4.0

INTRODUCTION

The fourth industrial revolution is known as Industry 4.0 in most German-speaking countries. Different terms for this concept can be found in other countries, such as

Smart Industry in the Netherlands or the Industrial Internet in the United States of America. Industry 4.0 is the production of goods and services with the help of technical components such as Big Data, Cyber-physical systems, the Internet of Things, social components like attractive workplace conditions and production components such as smart factories to increase the competitiveness of a country (Bulte, 2018). 50% of German companies are planning industrial networks, while 20% have already transitioned to the smart factory of Industry 4.0 which means that machines, people and production resources are in interaction (Bayraktar & Ataç, 2019). In Poland, digitalization of business process and automation in various sectors is in its infancy. The Polish industry is between reality 3.0 and 4.0. Specific solutions are introduced 'locally'. A comprehensive approach is rare when the introduction of culture 4.0 simultaneously covers various levels and areas of the company's operations (Polski Przemysł 4.0, 2018).

Thus, in a time of rapid, dynamic and unexpected social, economic and political changes affecting the global labour market (Przytuła, 2018), the companies must react and adjust fast to such challenges as Industry 4.0 which brings increasing automation and digitalization into management. Automation is the second most important strategic priority: 36% of companies plan to increase automation over the next 12 months through leveraging cloud computing and 13% by investing in RPA – Robotic Process Automation (Deloitte, 2016). The HAYS (2018) forecasts prove that nearly half (47%) of existing jobs are bound to be performed by machines within the next 25 years. Additionally, it is estimated that approximately 57% of jobs are at risk of automation in highly developed countries, while in the EU market it is about 54%. Digitalization is changing the organizational and functional structure of each company. This term means an ever-increasing use of technology and corresponding substantial changes in numerous domains of business and society. This notion is also true for human resource management (HRM) (Strohmeier, 2020). In this context, ambidexterity can be seen as a solution for digital transformation.

'Ambidexterity' comes from Latin and means 'both (hands) right', in other words being equally adept in the use of both hands. It is a concept that often comes up when companies restructure themselves to embrace digital transformation. Studies have shown, however, that organizations have to continuously reconfigure their activities to meet changing demands in their internal and external environments (Raisch & Birkinshaw, 2008).

Organizational ambidexterity refers to the ability of an organization to both explore and exploit-to compete in mature technologies and markets where efficiency, control and incremental improvement are prized and also its competing in new technologies and markets where flexibility, autonomy and experimentation are needed (O'Reilly III & Tushman, 2013). Exploitation is associated with activities such as 'refinement, efficiency, selection and implementation', whereas exploration refers to notions such as 'search, variation, experimentation and discovery'. Exploitation and exploration therefore require fundamentally different organizational structures, strategies and contexts (Raisch & Birkinshaw, 2008). In this context of digital transformation in companies, ambidexterity is considered as a modern organizational concept managing current strategical requirements as such innovation for new digital solutions vs. efficiency in existing processes in fast developing smart factories as Garaus et al. (2016) pointed. According to Andriopoulos and Lewis (2010), Schnellbacher and Heidenreich (2020) and Uotila (2018) the organizational ambidexterity long-term success depends on the ability to explore new opportunities and to exploit existing capabilities. A lot of research has been done on Industry 4.0 from a

technical point of view, but there has been little research done on what it is meant for the workforce or society as a whole (Habraken & Bondarouk, 2017). According to Habraken et al. (2018), HRM research mainly focuses on how the HR function can acquire digital competencies or make use of technology in HR domains, such as using new technologies for administration (e-HRM), recruitment (video interviews, CV scanning systems), training (virtual reality glasses, or serious gaming) or performance appraisal (continuous feedback apps). However, the impact of technology on the future of work and consequently the role of HR is much broader and may lead to downsizing, restructuring the content of jobs, teams, or departments, decreased quality of work, working conditions, or employment relations. Also, a growing body of literature suggests organizational ambidexterity is influenced by companies' HRM practices (Malik, Sinha, Pereira, & Rowley, 2019) especially concerning individual knowledge and organizational capabilities. Schnellbächer and Heidenreich (2020) showed that ambidextrous knowledge offering (exploration) leads to higher performance in settings where radical innovations are required; in contrast, ambidextrous knowledge seeking (exploitation) leads to increase in performance where settings required incremental innovation.

Fourné, Rosenbusch, Heyden, and Jansen (2019) revealed in their meta-analysis that high technology companies benefit from a special type of ambidexterity, that is structural one, which is discussed in the next section. Therefore, there is necessity for smart factories focusing on ambidexterity to balance the need of innovation vs. efficiency. Two transformation paths are under consideration for companies: organizational vs. individual ones (Mom, Chang, Cholakova, & Jansen, 2018). The central issue is how to transform the 'context' for ambidexterity in companies by changing their capabilities, that is organizational structure, culture, IT, processes/routines, leadership or employee competencies and behaviour. For building an ambidextrous organization, Stelzl, Röglinger, and Wyrtki (2020) identified these capability areas. These areas could be applied for running a situational analysis and defining the maturity level as a starting point for the transformation journey on the organizational level. For the employee level, Rosing, Frese, and Bausch (2011) argued that the leadership behaviour for implementing ambidexterity requires 'two complementary sets of leadership behavior that foster exploration and exploitation in individuals and teams: opening and closing leadership behavior'. Zacher, Robinson, and Rosing (2016) showed in a field study that opening leadership impacts exploration behaviour of employees, whereas closing leadership influences their exploitation behaviour. Therefore, the HR is in charge of assessing the maturity level of ambidexterity and guiding through this transformation on organizational vs. individual levels.

This requires, for instance, redefining the new role of HR to be fully engaged in running 'old processes', but facing new, digital and technological challenges.

Kang and Snell (2009) propose that each component of intellectual capital (human, social and organizational) resides in both approaches of ambidexterity, creating unique configurations that are set to align the objectives and purposes of the organization. In ambidextrous organizations, this allows to seek co-existence of explorative and exploitative approaches and the management of several layers of intellectual capital. These processes require proper handling and effective interventions. Several researchers have highlighted the importance of HRM in assessing, developing, monitoring and influencing an organization's intellectual capital, Kang and Snell (2009) provide several configurations of how HRM can enable this in ambidextrous companies by promoting the practice areas of development (e.g. training, job rotation), employee relations (e.g. advancement, career

planning) and performance systems (e.g. job design, performance appraisals) to achieve both stability and continuity.

From an organizational point of view as Garaus et al. (2016) stressed the necessity for an integrated, ambidextrous HRM system which focuses on the exploration path, on *employment practices* and on the exploitation path, on *work practices* ending up in collaboration, knowledge integration and learning. The authors provide evidence that these practices do not need to be distinct or even conflicting, to accommodate ambidexterity, and argue that practices should be evolved in an integrated fashion to allow both approaches to connect and ensure the ability of the company to integrate knowledge.

Similarly, Malik et al. (2019) illustrate how efficiency can be achieved by simultaneously adapting HRM practices seeking both continuity and adaptation. In doing so, HRM ensures that the intellectual capital can be re-aligned or re-configured through various practices at different levels to accommodate the explorative *and* exploitative requirements of the company simultaneously, especially in the context of global competition.

Thus, we focused on the direct impact of Industry 4.0 on the HR function (recruitment, performance, talent management, development) through the lenses of the ambidexterity concept (Schnellbächer & Heidenreich, 2020) because the mandate of HRM is to guide and support organizational and individual transformation (Garaus et al., 2016; Stelzl et al., 2020).

BEST PRACTICES FOR AN AMBIDEXTROUS ORGANIZATION

Smart companies (companies with Industry 4.0, German term, see Pfeiffer, 2017) apply digitalization by implementing artificial intelligence (AI) for their business products and solutions. For the management, this means to think twice about optimizing established business processes with automation, artificial intelligence as well as creating new, disruptive innovation for new digital products in the digital age. On the one hand, digitalization helps to increase the process efficiency of these established business processes and core business competencies developed in an existing pattern. On the other hand, innovation is created by applying digitalization or even AI to invent new products and services via disruption (O'Reilly III & Tushman, 2013).

What solution could we think of to integrate both aspects in working processes? This dual pattern of management in the current digital age is an important key aspect to add business value by applying organizational ambidexterity (O'Reilly III & Tushman, 2013). Ambidexterity focuses on both aspects of exploration (process efficiency) and exploitation (innovation) either within the teams along the business process or by defining separate teams for exploration and exploitation (structural ambidexterity). This creates a management perspective for driving digital transformation within the company. O'Reilly III and Tushman (2013) differentiate between three patterns of ambidexterity: structural, contextual and sequential.

First, applying the most common pattern, structural ambidexterity means separating exploration and exploitation into independent business units. Beyond the business units for existing processes, an innovation hub is created to explore new disruptive business ideas in flexible units. Then, there is evidence of a positive impact on company's performance (Jansen, 2005). His study revealed that the structural differentiation on ambidexterity is mediated through informal senior team and cross-functional interfaces (Jansen, Tempelaar, van den Bosch, & Volberda, 2009). Fourné et al. (2019) emphasize this type for high

technology companies. Second, contextual ambidexterity balances exploration and exploitation by making team members capable of creating a potential for efficiencies and be innovative at the same time, for example through simultaneous activities in one organizational unit. The success factors for implementing contextual ambidexterity pointed out by Birkinshaw and Gibson (2004) are the social support of the management and the high-performance organizational context with high achievement motivation of the staff.

Third, sequential ambidexterity covers a temporal sequence of exploration and exploitation (e.g. one follows the other) which is applied in the new digital business opportunities. Less evidence for the increasing impact on performance was given (He & Wong, 2004), but Chou, Yang, and Chiu (2017) showed that sequential ambidexterity, as a temporal switching capability, is positively related to new product performance. The type of business strategy and absorptive capacity moderated the impact of the sequential ambidexterity on new product performance.

The added value of different ambidexterity patterns depends on the organizational context in the light of industry 4.0 (see Pfeiffer, 2017). Based on the best practices in the literature of the subject, we illustrated this with three company cases from Germany. The first business example from 'Munich Re' goes for the structural pattern, the second case from 'Trumpf' focuses on the contextual pattern of ambidexterity, whereas the final example of the 'BMW' company presents sequential ambidexterity.

'Munich Re' as an Example of Structural Ambidexterity

This re-insurance company with 40,000 employees and 52 billion Euro revenue in 2019 was founded in 1880. Dietl (Dietl, 2020) described in his article the case study of why the re-insurance company Munich Re has chosen structural ambidexterity: *Munich Re offers insurances for catastrophes which are very rare, risk calculation is the essential mandate of everyday work which might limit creative thinking and innovatio*n. The innovation for new products was limited because of some structural and cultural barriers. Therefore, the top management decided to set up cross-functional teams with up to 300 employees who were upskilled in agile working methods to understand customer demands. They worked in a very dynamic environment within an innovation hub close to the board. This structural ambidexterity ensures service excellence in existing business processes in the large corporation and resulted in a new organizational entity Munich Re Ventures, a new digital unit in a startup setting, and special technological units for the Internet of Things. Finally, a new spin-off stands for focusing on a niche, evaluating market opportunities, fast iterative processes ('build, measure and learn') and customer-centric focus. Beyond these structural changes, Dietl (2020) summarized the following success factors for more innovation at Munich Re: top management focus, freedom for disruptive innovation, long-term resource allocation and budget for innovation even in times of revenue losses because of COVID-19. The final management lessons learned are to acquire skilled employees, establish a culture for innovation and passion to experiment although the outcome is not yet predictable.

'Trumpf' as an Example of Contextual Ambidexterity

The Trumpf company for machine tools, laser technology and electronics for industrial applications was founded in 1923 (Trumpf, 2021). The company is a market and technology leader in machine tools and lasers for industrial manufacturing. Software solutions pave the way to the Smart Factory. Hönl (2021) pointed that contextual ambidexterity has

the advantage over structural ambidexterity to integrate the old and the new business perspective (*traditional mechanical engineering practices vs. artificial intelligence*) in heterogeneous, cross-functional teams in parallel for maximizing customer benefits. He also explained this type of ambidexterity as a dynamic, iterative, so-called agile development; the new role of 'product owner' within an agile team focuses on managing the technical content side and feasibility, while agile managers (former line manager) create the appropriate organizational framework, essentially by making it adaptable and facilitating continuous learning and collaboration across boundaries in the light of contextual ambidexterity. In Hönl's interview (2021), Duwe argued that new capabilities need to be combined with existing knowledge; therefore training on these capabilities is essential. Finally, Duwe (2018) summarized that this contextual ambidexterity is a key success factor for digital transformation, thus leadership behaviour should encourage thinking in both patterns in parallel. In consequence, the current business leaders apply contextual ambidexterity by flexibly switching their and their employees' mindset and capabilities between exploration and exploitation in the business processes, enabling the necessary frame for new work behaviour, tools and collaboration for their teams and employees, as in agile project management. The lesson learned from this case is to increase capabilities by developing skilled employees in interdisciplinary fields combined with an agile approach.

'BMW' as an Example of Sequential Ambidexterity

Bayerische Motoren Werke AG, commonly referred to as BMW, is a German multinational corporation that produces luxury vehicles and motorcycles. The company was founded in 1916 as a manufacturer of aircraft engines. Birkinshaw, Zimmermann, and Raisch (2016) identified BMW as an example of sequential ambidexterity: 'BMW's successful sequential alternation is its culture that encourages employees to critically reflect on their strengths; in the phase between 2006 and 2010, when front-line managers were working hard to optimize BMW's continuous profitable growth in its established model range, top executives began to meet with customers, industry experts, and researchers to discuss the future of mobility'. This is a good example of how different internal stakeholders dealt with sequential ambidexterity. Birkinshaw et al. (2016) summarized: 'During exploitative phases, front-line managers rely primarily on seizing capabilities, whereas top executives emphasize their sensing capabilities to identify the right moment and prepare the organization for the shift towards an exploratory focus. Conversely, during explorative phases, front-line managers primarily deploy their sensing capabilities, while top executives emphasize seizing capabilities, to prepare the organization for a shift back to exploitation'. In a nutshell, BMW realized the sequential pattern less within a team focus and more with many stakeholder groups on different organizational levels.

Overall, Luger, Raisch, and Schimmer (2018) criticized that ambidexterity is not the only best fitting solution for any strategical movement because this focus could result in defensive activities by the management if dynamic, transforming external forces in the environment are not taken into account. Luger et al. (2018) favours a continuum of exploration-exploitation with balanced resource allocations; in the long-term run, companies should focus on 'capability-building processes (to balance exploration and exploitation) and capability-shifting processes (to adapt this balance to the changing requirements)'. In a current cross-country comparison, Bustinza et al. (2020) revealed in the product service industry that sequential exploitation-exploration pathway maximizes company performance, but the optimal tested pattern consistent across all the world regions (except Japan) is the contextual ambidexterity impacting company performance. In

contrast, Clauss et al. (2020) showed in a survey-based study in German mid-sized engineering companies how ambidexterity, exploration and exploitation affect the self-assessed competitive advantage. They favoured an exploration strategy of innovation processes with radically new knowledge, products and services, linking this with strategic agility as only exploitation has not increased competitive advantage, whereas an ambidextrous strategy on its own could negatively impact the competitive advantage.

However, our best practices focused more on structural ambidexterity which is an excellent entry point for the first implementation of ambidexterity on organizational structural level. Next, on the individual level, the leader and employee behaviour requires a transformation step in the direction of sequential or contextual ambidexterity accompanied by agile working methods. These agile working methods push the radical innovation like it was revealed by Clauss et al. (2020) and Trumpf (2021).

To conclude, we argue that a hybrid integrative pattern of contextual and structural ambidexterity with flexible staffing and job rotation between organizational units, temporary project teams, is worth considering for a smart industry. Relying only on structural ambidexterity with an independent innovation hub is not enough.

If organizational ambidexterity is implemented, there is a crucial issue of capability in terms of either allocating the resources to flexible business demands or developing employee capabilities progressing on the ambidexterity maturity level (Stelzl et al., 2020). HRM practices need to be flexible for both patterns of working along a continuum (Luger et al., 2018). Furthermore, HRM practices should extend their traditional services with add-ons for supporting the flexible explorative working style. In a nutshell, several HR practices are highlighted to stress the necessity for HRM adaptations due to digital transformation (Buisson, Gastaldi, Geffroy, Lonceint, & Krohmer, 2021; Seeck & Diehl, 2017; Shipton, Sparrow, Budhwar, & Brown, 2017). This research field is developing right now, so our discussion is more an outlook rather than a complete summary. Beyond this focus, HRM practices have to foster further current challenges for digital transformation within their companies. Hansen, Güttel, and Swart (2017) linked the ambidexterity theory with the HRM strategy and system in order to evaluate, within a company, which HR system is needed based on current strategic requirements (i.e. degrees of flexibility vs. innovation) and argued that four different HR systems (1–4) are required within the same company: (1) compliance vs. (2) productivity-based systems for exploitation needs or (3) collaborative vs. (4) commitment-based HR systems for exploration enhancement. Balancing ambidexterity in business, HR systems should apply the above solutions.

CHALLENGES FOR HRM

There is a price to be paid in building HRM systems to serve and help the enactment of ambidextrous organizations, and the number of challenges to companies that seek ambidexterity are well known. Because ambidextrous organizations require parallel actions that may often deem incompatible, much time and resources are required to build the kind of HRM practices that can be effectively integrated to achieve company continuity and development simultaneously. In addition, HRM professionals should be endowed with a specific attitude and mindset that will allow them to boldly depart from typical traditional approaches or even remain inculcated in one approach. Therefore, preparation and the right frame of mind is required (Buisson et al., 2021). Moreover, an HRM system in an ambidextrous environment implies additional complexity, and with complexity come more

uncertainties to deal with. Therefore, HRM professionals need to design and implement HRM systems to support work that requires dual capabilities, to allow the company to achieve ambidexterity (Ferraris, Erhardt, & Bresciani, 2019). Finally management support is required to enable a sense of involvement and participation that is required for employees to explore new ways of behaving while maintaining efficiency at work (Prieto-Pastor & Martin-Perez, 2015). Human resource professionals are concerned with overseeing the HR of organizations, which, through Industry 4.0, will be affected by technological tools and innovative technology (Jesuthasan, 2017). Technological disruption, robotics and automation threaten to replace low-skilled, routine jobs (Naudé, 2019). The increase in technological capability will not only cause an increase in unemployment but will also change the nature of work and the workforce because of the underlying trends in technology that accelerate job automation (Dhanpat, Buthelezi, Joe, Maphela, & Shongwe, 2020).

Many scholars have examined various challenges of human resources management regarding organizational ambidexterity, including leadership (Cunha, Fortes, Gomes, Rego, & Rodrigues, 2019; Jansen et al., 2009; Nemanich & Vera, 2009), top management characteristics (Lubatkin, Simsek, Ling, & Veiga, 2006; Simsek, 2009; Smith & Tushman, 2005; Venugopal, Krishnan, Kumar, & Upadhyayula, 2019), employee motivation (Ahammad, Glaister, & Junni, 2019) and organizational culture (Wang & Rafiq, 2014). In a situation of ambidexterity, companies need to successfully combine different activities over time and space, and this brings enormous challenges for HRM, particularly in the matters of competency management (Buisson et al., 2021). Following Pfeifer's (Pfeiffer, 2017) argumentation, there is a global work reorganization for new capabilities of the workforces, either upskilling or downsizing employees, depending on the specific job families. O'Reilly III & Tushman (2013) argued to focus on dynamic capabilities and relocating these organizational capabilities by covering all three types of ambidexterity: 'Leaders must be able to orchestrate the allocation of resources between the routine and new business domains'. There has also been substantial, though insufficient, research on human resource development as a challenge for HRM in the context of ambidexterity and smart industry. Specifically, vast research exists in examining exploratory and exploitative learning (Dixon, Meyer, & Day, 2007; Kostopoulos & Bozionelos, 2011). Thus, our attention is focused on re-training and new competencies required in an ambidextrous organization. These result from digitalization of various processes in an organization. On the one hand, digital technologies are employed to support operational HR practices, such as recruitment or compensation. On the other hand, the operational application of digital technologies implies a 'liberation' of HR professionals from the operational burden, and makes them focus on value-added strategic activities of HRM (Strohmeier, 2020). Implementation of Industry 4.0 will pose new challenges for re-training. This, in particular, includes the need to equip employees with certain competencies that are crucial in the current labor market.

In the strategic document *European Digital Competence Framework for Citizens* (Vuorikari, Punie, Carretero, & Van den Brande, 2016), the European Union underlines the importance of digital competencies with key components, such as information and data literacy to articulate information needs, to locate and retrieve digital data, information and content; communication and collaboration to interact through digital technologies while being aware of cultural and generational diversity; digital content creation to create and edit digital content; safety to protect devices, content, personal data and privacy in digital environments; physical and psychological health protection to be aware of digital technologies for social well-being and social inclusion; and the last one, problem-solving to

identify the needs and problems and to solve conceptual problems and problem situations in digital environments (Vuorikari, Punie, Carretero, & Van den Brande, 2016).

Other researchers go a step further, indicating the need to strengthen cognitive competence, social and emotional adaptability, and resilience (Agrawal, De Smet, Lacroix, & Reich, 2020) that goes in line with the literature and report review made by Przytuła, Strzelec, and Krysińska-Kościańska (2020). It is about finding employees with the most needed competences of the future labour market expectations, which can be achieved through re-skilling or re-training in the process of Continuous Professional Development (CPD). Industry 4.0 transforms jobs and competencies profiles as a result of two trends. First, traditional manufacturing processes characterized by a very clear division of labour will now be embedded in a new organizational and operational structure where they will be supplemented by decision-taking, coordination, control and support service functions. Second, it will be crucial to organize and coordinate the interactions between virtual and real machines, plant control systems and production management systems (Kagermann, Wahlster, & Helbig, 2013). Organizational ambidexterity will expect the organization to explore on the one hand and exploit on the other, in a turbulently changing environment. In this context, Industry 4.0 and organizational ambidexterity will require fundamental changes to the way that professionals are to be trained and the competencies they are to be provided with. In this vein, the introduction of HR Data Analytics as part of the key competence indeed requires rethinking of the skill repertoire as both technical and human considerations come into play (Eubanks, 2019; Rasmussen & Ulrich, 2015) and, above all, an appreciation of HR Data Analytics is placed within a broader strategic perspective (Falletta & Combs, 2020). The HR function can contribute to business results (Habraken et al., 2018; Habraken & Bondarouk, 2017; Jorgensen & Becker, 2017; Strohmeier, 2020), but to achieve this, HR specialists should understand and interpret financial data, have skills and knowledge helping them to translate reality into technological language, have a good command of the dynamics in the sector in which the company operates (Bayraktar & Ataç, 2019).

TOWARDS BETTER HR PRACTICES – EXAMPLES FROM COMPANIES OPERATING IN GERMANY AND POLAND

Patel, Messersmith, and Lepak (2013) emphasize that 'although the ability to achieve ambidexterity arises out of the human resource base itself, it is likely to be supported by the system of HRM practices employed by an organization'. To contribute to HR business practice, we looked at HR practices where smart solutions can be simultaneously applied while balancing between exploitation and exploration. We provided examples of ambidextrous approaches in companies operating in Germany and Poland based on interviews with key HR informants. As a result of their personal skills or position in an organization, key informants are able to provide more information and a deeper insight into what is going on around them. By definition, they all had formal roles which exposed them to information about the strategic and operational issues in company (Marshall, 1996). The first respondent is the Head of Global Talent Management at Schott AG with its headquarters in Germany. The company manufactures glass in production sites in 34 countries. The Schott corporation employs 16,500 people worldwide, including 5,900 in Germany. The global approach is focused on applying digitalization and AI in the management process, including HR practices.

The second respondent is an HR Manager for Production Operations of 3M Poland, which is a technological and production company that is a branch of the international 3M concern. 3M operates in 4 areas: Safety and Industrial, Transportation and Electronics, Health Care and Consumer Products. The company has subsidiaries in 70 countries with more than 90,000 employees worldwide. Using science and acting in accordance with the principles of sustainable development, 3M creates innovative solutions that improve the quality of life and safety standards in the workplace, reduce the risk of infection, support the treatment process, increase the comfort of living at home, and are even used in the space industry. Every year, the company invests ca. 5.9% of its sales in research and development (R&D), as a result of which approximately 1,000 new products are created annually. The company policy is focused on innovation and sustainability as its core values, and these are also reflected in the HR practices.

The interview questions were as follows:

(1) What are the general challenges businesses are facing in the era of Industry 4.0?
(2) What is the example of structural ambidexterity in your company/in HR?
(3) Are there any down-top initiatives taken by your employees, in a collective effort with no written rules or routines that develop your organization? (as an example of contextual ambidexterity)
(4) Did your company change its business model to better realign to environmental challenges? (as an example of sequential ambidexterity)
(5) What are the most required employee competencies because of Industry 4.0?
(6) How do you use digitalization in HRM processes?

HR Learning Results from the Interviews

Below we present the HR business practices in both companies concerning each research question.

Ad.1. What are the general challenges businesses are facing in the era of Industry 4.0?

The key *business challenges* for *Schott AG* are digitalization and introduction of innovations in IT and R&D. The respondent pointed out: *We have a clear and structured roadmap for digitalization and Industry 4.0 in our company [...] We believe that the two enablers for our business strategy 2026 are digitalization and best teams. Digitalization is covered by 3 hubs (operation technology (OT) hub, IT hub and R&D hub) with new roles of Artificial Intelligence scientists.*

In *3M*, the key challenges in the era of Industry 4.0 are in employees' competencies, skills shift towards virtuality, AI, digital affinity and redefinition of current job profiles, as mentioned by our interviewee: *In working with augmented reality, artificial intelligence or remote system controls, digital affinity, and competencies to operate in this new reality, are a must.*

Ad.2. What is the example of structural and contextual ambidexterity in your company?

Ad.3. Are there any down-top initiatives taken by your employees, in a collective effort with no written rules or routines that develop your organization?

Both structural and contextual ambidexterity was identified in Schott's business model. According to our HR key informant: *As an example of structural ambidexterity in our company, I would point to three units, e.g., OT, IT and R&D. Founding these innovation hubs confirms the structural ambidexterity, and they are structured as follows: (1)*

Operations technology (OT) based at HQ in Mainz directly reports to our board. The OT focuses on Industry 4.0 and digitalization with different business units globally. (2) The IT hub is within the IT department. (3) R&D is a small team of scientists working with AI and big data.

In *Schott AG*, a combined approach of digitalization with a lean management champion network serves as the best practice for implementing contextual ambidexterity on a global basis. Our respondent pointed to down-top initiatives taken by Schott AG employees in a collective effort with no written rules or routines: *Yes, we implemented previous initiatives taken by employees who serve as change agents in a network of lean champions as bottom-up support in each production site. This combined approach of Lean Management and digitalization by the OT hub is the best practice for contextual ambidexterity.*

Similarly to Schott AG, also in 3M Poland both examples of organizational ambidexterity – structural and contextual – were identified. The structural ambidexterity exists in the form of an innovation hub and cross-functional units like information technology (IT), operations technology (OT) and R&D which are coordinated by highly educated experts and science advocates. The interviewee explained that: *3M introduced a program framework which required arranging multidisciplinary, cross-functional teams. The traditional definitions of IT and OT, as an example, needed to be explored and revised to allow these two groups to create synergy. On top of that, we bring together expertise related to machine design, automation, manufacturing technology, research, and development needed to build the new ecosystem [….]. We have established a group of science advocates who engage the next generations to pursue their careers in STEM fields.*

As regards contextual ambidexterity, the improvement in communication and exchange of information is a major bottom-up initiative that leads to employee engagement, motivation and proactivity. According to our respondent: *Our major goal of bottom-up ideas is to create a culture of open exchange of ideas, walking the talk, getting inspiration for smaller and larger improvements. We created such platforms to exchange information: (1) Continuous improvements – is enhanced by rotating leaders of daily production meetings, visualization of the problems and actions by linear process coaching, problem-solving worksheets; (2) Safety and Health – aims at engaging all levels of employees in proactive preventive thinking to report potential incidents. (3) See and Act program (GROW) where leaders of all levels talk to employees to engage and motivate them by showing interest and having* a *personal conversation.*

Ad.4. Did your company change its business model? (as an example of sequential ambidexterity).

There were some initiatives taken by these companies to better realign to environmental challenges as an example of *sequential ambidexterity*. In *Schott AG*, the key informant said: *Yes, due to a new business strategy, we defined business goals for alignment to sustainability by getting climate-/CO-neutral in 2026 at our core business; glass production is very energy-intensive.*

The response of *3M* to current environmental challenges is clearly stated in the strategic plans and, according to the interviewee: *The switch to renewable energy is part of 3M's strategy focused on climate protection with efforts to innovate in order to cut emissions from industry and reduce our environmental footprints. Thanks to the application of scientific and technological knowledge, as well as the constant introduction of innovative products and solutions, 3M has been regularly reducing carbon dioxide emissions since 2000. Actions taken today are to result in the achievement of total (100%) carbon neutrality by 2050. 3M*

has also committed to reducing water consumption at its production facilities around the world over the next decade – by 10% by 2022, by 20% by 2025, and by 25% by 2030. We're currently working on 100% transition to LED lighting, which will soon save 17 million kWh of energy.

Ad.5. What are the most required employee competencies because of Industry 4.0?

As regards the research question concerning *the most required employee competencies* in the view of Industry 4.0, *Schott AG* relies on digital competencies of new employees: *In our company, we expect employees to learn new digital competencies described within the EU framework we applied, however, I don't remember all the competencies in detail, the EU digital competency framework is the basis for our learning journey and paths.* Digital competencies of the employees in production sites are a core element of career development:

> Everybody got a map for his/her learning journey with stickers, which was implemented by the local HR managers, as our HR network from headquarters to regional to local HR managers, works very well. We implemented a framework for digital competencies which is the basis for the learning journey and paths.

In *3M*, we found a more advanced and mature approach to employee competencies. The respondent said that: *In 3M, we have experts in all of those fields, most of them highly educated with Ph.D. degrees and years of experience in the industry, labs and universities* and the most required competencies are STEM skills – technical skills, such as IT, mathematics and engineering to operate advanced machines and systems. According to our key respondent: *New competencies of the employees are needed for 3M and these include STEM and digital competencies that the company develops via courses on Data science, digitalization or Machine Learning, engaging Industry 4.0 solutions, such as virtual reality (VR).* 3M company is focused on employees' analytical skills, but simultaneously supports those who are willing to learn and reshape their skills and competencies flexibly: *What is very important is the openness to learn and grow. We are developing programs for both production and non-production employees that help unblock the past and shift towards the future, show how the growth mindset positively impacts individuals and the organization.*

Ad.6. How do you use digitalization in HRM processes?

In relation *to the last research question* for *Schott AG*, HRM focuses on the digitalization of its processes, such as HR software implementation, and partly contributes to contextual ambidexterity by fostering innovation, such as digital learning programs, online assessment centres, or leadership coaching within the talent management process, as was pointed by our key informant: *Our talent management process was adapted to digital elements, for example tools for potential analysis, such as an assessment center or coaching in e-tools and e-coaching. We created small learning units instead of long-lasting training programs for the talents. Our talents are self-responsible for choosing their learning units on urgent demand.*

Performance management was simplified to contribute to organizational ambidexterity in business: *We streamlined our previous complex performance management system by simplifying the performance talks to several feedback talks every 3 months during a business year and focusing on two simple questions: What do you contribute and how do you contribute?*

In *3M*, there is a great emphasis on digitalization of HR processes with particular attention to recruitment: *In recruitment, to be closer to potential candidates, we use social media, especially LinkedIn that connects professionals and Facebook to build employer branding and attract potential candidates. We also use an Automated Tracking System to monitor the applications and manage candidates' data. Additionally, as we continuously*

invest in Industry 4.0, we recruit employees with experience in programming Programmable Logic Controllers, Visual Basic and SQL, mechatronics, robotics, data analysis, experience in implementation of historians, ability to work with the Internet of Things (IOT).

As an example of an ambidextrous recruitment process, we have recently created new roles related to the implementation of Industry 4.0 projects, directly related to machine-learning – Digital Shop Floor for Data Engineer positions. To assess the skills, we have engaged our current employees with AI, IT, machine learning expertise, e.g. R&D employees from Poland and abroad.

To promote analytical skills, 3M offers various internal development courses for employees: *In HR Development, we use virtual training for manufacturing employees via virtual training center for warehouse operations with the use of simulation and 3D. In the area of data science, one of the courses we offer is Machine Learning – this internal training is run by a 3M employee teaching at the Minnesota University, and is about searching for and using interdependencies in big data sets. Applications, such as Netflix, YouTube, Siri, use machine learning. The course is addressed to all those who can use data science in their work.*

CONCLUSIONS

We conclude that the essential mandate for HRM in the twenty-first century is to deliver modern HRM frameworks for supporting the management and employees in routine and innovative work environments. In this digital age, HRM should help by implementing a flexible working culture, dynamic workforce capabilities and working tools in a smart factory; for HR professionals in companies stick to the so-called New Work concept (Bergmann, 2019). Facing the business challenges in the digital age (big data, global connectivity, AI), the HR management increases the maturity level for ambidextrous approaches: structural, contextual or sequential ones (Stelzl et al., 2020).

For the purposes of this chapter, we interviewed HR key informants representing two corporations (based in Germany and Poland) that are using digital and innovative solutions as a response to Industry 4.0. The respondents identified similar challenges in their businesses: sustainability (getting climate/CO-neutral), digitalization and innovation, AI, and new interdisciplinary competencies of employees 4.0 which were also pointed by Buisson et al. (2021) and Bulte (2018). In both companies, we identified examples of structural ambidexterity, such as innovation hub, IT, OT and R&D units which create synergy and add value to the whole organization. The interdisciplinary teams of highly qualified experts from machine designs, automation, manufacturing technology and AI cooperate on the verge of industry, business and science.

We also asked about any down-top initiatives taken by employees in both companies, understood as collective efforts with no written rules or routines that contribute to the development of these organizations. The respondents pointed to various solutions, such as a network of change agents in all corporate units, platforms for exchanging information, implementation of lean management (linking digitalization with existing change initiatives), engagement of all levels of employees in proactive, preventive thinking to follow the Kaizen method. These are examples of contextual ambidexterity and according to Mom et al. (2018), the *bottom-up* practices are mediated by individual behaviour (self-efficacy and intrinsic motivation) and influence organizational ambidexterity outcomes. Also regarding contextual ambidexterity, Simsek et al. (2009) argued that organizations need to focus on multiple levels: individual, group and organizational. Individuals must allocate their efforts to manage the dual learning modes of exploration and exploitation in a way

that they seek help and support from their managers (Nemanich & Vera, 2009). According to Zacher et al. (2016) ambidextrous leadership behaviour enables the new required employee behaviour. Sequential ambidexterity was described as changes introduced in the business model due to new environmental challenges. The practices in both companies are still *in statu nascendi* and mostly focus on sustainability, green electricity and the achievement of carbon neutrality within the next decade.

Regarding the *most required competencies of Industry* 4.0, both Schott AG and 3M valued digital competencies, virtuality, STEM education, analytical skills, openness to learn and grow, creativity and flexibility. These requirements are in line with 'The Accreditation Board for Engineering and Technology (ABET)' which recommends the following 'must-have abilities' of successful professionals: apply STEM knowledge, analyze and interpret data; identify, formulate and solve engineering problems; understand the impact of engineering solutions in global, economic, environmental and societal contexts; use the techniques, skills and modern engineering tools necessary for engineering practice (ABET, 2021). Similarly, Hernandez de Menendez et al. (2020) concluded that there is a vast literature that reviews the competencies needed in Industry 4.0. However, the common ones could be considered those related to the ability to use and interact with Industry 4.0 technologies, data analysis, technical knowledge and the need for personal skills (Hernandez-de-Menendez, Morales-Menendez, Escobar, & McGovern, 2020).

Concerning *HR practices* that are supported by digital solutions in both companies, the interviewees pointed to recruitment, performance management and development of employees – mostly affected by automation and digital tools. Companies that implement Industry 4.0 need to understand that their employees must continually acquire new skills. This can be achieved by offering frequent training and education programmes to employees or by hiring external talent with the needed abilities (Hernandez-de-Menendez et al., 2020). Overall, for our key informants, organizational ambidexterity seems to be a valid concept combining their efforts on efficiency with innovation goals operationalized in business units and in a daily teamwork confirmed by empirical studies on ambidexterity's impact on business performance by considering different contextual settings (Junni, Riikka, Taras, & Tarba, 2013). Because of the imperative of new digital technologies (big data, global connectivity, AI), a new HR operating model is necessary. Rehse, Agarwal, Rodt, and Twesten (2019) suggest updating current HR services by implementing AI as core elements. Flores, Xu, and Lu (2020) call for new structural interactions among employees, additional qualities to human capital and different ways to identify the competencies for the workforce.

To conclude, HR managers are required to support their business units with implementing the digital transformation together with organizational ambidexterity, and simultaneously the HR teams are required to plan and implement their own HRM digital transformation for their core HR processes (e.g. employee recruitment and development, HR analytics). HR professionals might push forward their own digital and AI innovations by applying contextual ambidexterity within the HR teams in this disruptive and digital twenty-first century.

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