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FACILITATING RADICAL FRONT-END INNOVATION THROUGH TARGETED HRM PRACTICES

A CASE STUDY OF PHARMACEUTICAL AND BIOTECH COMPANIES

ABSTRACT

This study extends the knowledge of the HRM–innovation relationship and examines how innovation-facilitating bundles of human resource management (HRM) practices are applied to facilitate radical pharmaceutical front-end innovation (FEI). The empirical investigation is an explorative case study of science-driven FEI and HRM practices across one in-depth case study and seven validation studies among international pharmaceutical and biotech companies. The findings provide a theoretical overview of key HRM practices in support of radical pharmaceutical FEI as well as an empirical mapping of how innovation-facilitating bundles of HRM practices are applied to actively develop radical, science-driven pharmaceutical FEI, including the identification of the key innovation challenges and opportunities involving innovation-facilitating HRM practices in pharmaceutical FEI. The article contributes to the existing innovation literature in terms of identifying how radical FEI may be facilitated through the application of innovation-facilitating bundles of HRM practices. The empirical contribution and managerial implications provide nine specific suggestions for how pharmaceutical management groups can better support radical pharmaceutical FEI through targeted HRM practices. The derived results of the study also underline inherent challenges of the pharmaceutical industry and regulations (FDA) that may not stimulate radical innovation, which cannot be resolved by HRM, but require the attention of policy-makers. The value added lies in the specificity of the empirical, pharmaceutical context in which the issue of supporting radical, science-driven FEI is investigated.

Keywords: *Front-end innovation, radical innovation, HRM practices, case study, pharmaceutical and biotech industry*

Practitioner Points:

- The article shows how radical front-end innovation can be actively supported through nine targeted HRM practices in the context of pharmaceutical companies
- The article provides knowledge of the specific challenges of pharmaceutical, radical front-end innovation and how to potentially overcome them
- The article addresses the unique challenges of front-end innovation in science-driven and knowledge-intensive companies

Biography

Annabeth Aagaard (Ph.D., MsC) is an Associate Professor at Aarhus University, Department of Business Development and Technology, and holds a PhD in Pharmaceutical front-end innovation. She is a partner of Stanford Peace Innovation Lab, Denmark and is the director of MBIT (Multi-Business-Innovation-Technology) Lab counting 20 employees. She has a total of 20 years of experience with innovation, management, business modeling and sustainability drawing on experiences in the academic, public and private sectors, where she was formerly a manager and management specialist working with top 100 Scandinavian companies. She has published extensively on management, innovation and sustainability in peer-reviewed scientific journals and has authored nine academic books and management handbook, which are applied in the course curriculum at universities.

INTRODUCTION

Extensive research has been conducted in the field of new product development (NPD) in recent decades, and research in front-end innovation (FEI) continues to grow. Recent research underlines how the fuzzy front-end of innovation is different compared to other stages in the innovation process, and organizations might therefore need to manage this stage of the process differently (Brentani and Reid, 2012; Roper, Du, and Love, 2008). In their seminal work, Cooper and Kleinschmidt (1994, p. 26) revealed how “the greatest differences between winners and losers were found in the quality of pre-development activities,” and Reid and Brentani (2004, p. 170) even call the fuzzy front-end “the root of success.” Despite the impact of this phase, there are still few empirical studies clarifying FEI practices (e.g., Elmquist and Segrestin, 2007; Kim and Wilemon, 2002; Robbins and O’Gorman, 2015; Verworn, Herstatt, and Nagahira, 2008), but there are exceptions (e.g., Börjesson, Dahlsten, and Williander, 2006; Markham, 2013). While FEI has attracted attention in research, there is a lack of a generally accepted definition, as noted by Koen (2007) and Zhang and Doll (2001), and the terminology varies (Nobelius and Trygg, 2002). This article uses the Koen et al. definition of FEI, implying that: “FEI represents the activities that come before the formal and well-structured new product and process development (NPPD) or stage-gate model” (2001, p. 49).

Radical innovation is especially perilous as high-novelty NPD projects are very uncertain, which makes their front-end planning process unpredictable (Kleinschmidt, Koen, and Reilly, 2005; Vandenbosch and Clift, 2002). In examining radical FEI, the concept of radical innovation is first explored. Christensen (1997) explains radical innovation as: “Highly revolutionary or discontinuous, representing a new paradigm that can generate new wealth whilst transforming or displacing some parts or all of an established market.” Discontinuous innovations, as defined by Garcia and Calantone (2002) and Brentani and Reid (2012), entail “radically new” innovations (i.e., those requiring changes in both

existing technology and marketing infrastructure) and “really new” innovations (i.e., those involving either technology or marketing discontinuities). The comprehensive Radical Innovation Research Program at Rensselaer Polytechnic Institute defines a radical innovation project as one with the potential to produce “an entirely new set of performance features” or “improvements in known performance features of five times or greater” or “a significant (30 percent or greater) reduction in cost” (Leifer et al., 2000, p. 5). From the literature review, radical and discontinuous innovation and FEI would appear to be relatively well-defined, separate concepts. However, an established definition for radical/discontinuous FEI has yet to be identified. The studies by Veryzer (1998), Koen (2007), and Verworn, Herstatt, and Nagahira (2008) all revealed how FEI for incremental and radical innovation are inherently different in focus, scope, and duration. Ideas for incremental products would usually appear to be determined by the overall strategic planning process or as part of an idea suggestion program. Conversely, ideas for radical or breakthrough products typically begin with a strategic vision (Markham, 2002). In this study, a suggested definition for radical/discontinuous FEI (or FEI for radical/discontinuous innovation) is presented after having identified and explored the concept further (Aagaard and Gertsen, 2011): “Radical, discontinuous front-end innovation captures the generation, screening and selection of discontinuous ideas for revolutionary concepts with a strong potential to transform or displace some or all of the existing market, business and technologies.”

The management and support of radical FEI is highly complex, and the literature often points in different directions depending on the type, industrial context, and location of the study. However, several analyses highlight the importance of FEI regarding radical innovation and company performance (see Booz, Allen, and Hamilton, 1982; Brentani and Reid, 2012; Brunswicker and Hutschek, 2010; Duyck and Allen, 2006; Dwyer and Mellor, 1991; Florén and Frishammar, 2012; Markham, 2013; Poskela and Martinsuo, 2009; Reid and Brentani, 2004; Shenhar, Tishler, and Dvir, 2002; Verworn, Herstatt and Nagahira, 2008), and particularly in relation to pharmaceutical

innovation (Aagaard and Gertsen, 2011; Schramm and Hu, 2013; Sternitzke, 2010; Trotter, 2011). The importance of innovation to knowledge-intensive firms (KIFs) like pharmaceutical and biotech companies cannot be overstated and may even be a defining factor of KIFs, as emphasized by Lei, Slocum, and Pitts (1999). In defining the KIF concept, Swart and Kinnie (2003) suggest that it should be restricted to companies that create market value by exploiting tacit knowledge in novel circumstances via the effective management of a highly qualified workforce. This focus on the human and social capital inherent to KIFs creates challenges for HRM professionals in terms of acquiring and sustaining qualified knowledge workers and supporting the exploitation of knowledge (Boxall and Purcell, 2003).

Duyck and Allen (2006), Aagaard and Gertsen (2011), and Robbins and O’Gorman (2015) all point out the critical role of FEI in pharmaceutical innovation performance due to the duration of FEI, the unique characteristics and challenges of pharma, as well as the key decisions being made in the early innovation phases. Because of the lengthy duration and vast costs of pharmaceutical R&D, emphasis is put on failing faster to ensure a constant flow of internal and radical ideas for development (beyond the patents being purchased externally (DiMasi and Grabowski, 2007), which emphasizes the role of the front end of pharmaceutical innovation. As KIFs and science-driven organizations, pharmaceutical companies depend highly on skilled human resources and unique scientific competences. The ability to develop and commercialize radical (and pharmaceutical) product innovations successfully constitutes a dynamic capability that is difficult both to develop and imitate (Slater, Mohr, and Sengupta, 2014). This argument- and resource-based view underlines why HRM can play a critical role in facilitating radical pharmaceutical FEI.

Some 30 years ago, Kozlowski (1987) called for Human Resource Management (HRM) to be more distinctly embedded in organizational strategy in order to facilitate innovation. In support of this argument, Roberts (1988) emphasized that the four dimensions of staffing, structure, strategy, and

system support were central to successful innovation and that ensuring that the organization had the right kind of people – and that they were effectively managed – were critical staffing issues. Many questions regarding the relationship between HRM and innovation still remain unanswered, however, especially in non-manufacturing contexts such as KIFs (e.g. Frenkel, Korczynski, Shire, and Tam, 1999; Newell, Scarbrough, and Swan, 2001). The innovation–HRM relationship in knowledge-intensive firms (e.g., pharma and biotech) has been largely unexplored despite calls for research in this area (Jackson, Chuang, Harden, and Jiang, 2006), thereby constituting a key theoretical research gap that this article explores.

Many intuitively consider the two research traditions of innovation and HRM to be interconnected. As early as the mid-1980s, innovation researchers focused on HR practices as a key to successful innovation (e.g., Roberts, 1988; Wozniak, 1987). Leede and Looise (2005, p. 111) claim that, over time, innovation researchers have displayed more interest in HRM than vice versa, which seems plausible when considering the number of articles in the innovation literature incorporating HR themes compared to the input of technology, NPD, and innovation in HR articles. Nevertheless, it is first recently that efforts have been made to identify and describe the relationship between the two areas more precisely (see Aagaard and Andersen, 2015; Jiménez-Jiménez and Sanz-Valle, 2005, 2008; Laursen and Foss, 2003). Several studies indicate the contribution of HRM practices to product and technical innovation activities (e.g., Chen and Huang, 2009; Shipton et al., 2005, 2006; Walsworth and Verma, 2007), process innovation activities (e.g., De Saá-Pérez and Díaz-Díaz, 2010; Walsworth and Verma, 2007), and organizational innovation activities (e.g., Chen and Huang, 2009). However, no studies known to the author consider the relationship between radical pharmaceutical FEI and different types of HRM practices; a research gap that this article attempts to address in the context of the pharmaceutical and biotech industry. Based on the arguments above, the current study opens the black box of the relationship between HRM practices and radical

pharmaceutical FEI. The article contributes to the literature by exploring the following research question: *How are innovation-facilitating bundles of HRM practices applied to facilitate radical pharmaceutical FEI?*

The purpose of the present study is therefore to provide new knowledge of how to actively support and facilitate radical, science-driven pharmaceutical FEI through targeted HRM practices and bundles of HRM practices across the biotech and pharmaceutical industry. The research question is explored in studies of the FEI/research divisions in eight pharmaceutical and biotech companies. Interview sessions with a key representative of pharmaceutical research have been carried out to investigate the facilitation of radical, science-driven FEI/research through HRM practices. The data analysis is conducted using meaning categorization, and the findings from the study present the generic and specific bundles of HRM practices to be applied in active support of radical pharmaceutical research/FEI.

This research study contributes to the innovation literature in three ways. First, a mapping is conducted of how innovation-facilitating bundles of HRM practices are applied to facilitate radical FEI. Second, empirical support is provided of how innovation-facilitating bundles of HRM practices are applied to facilitate radical pharmaceutical FEI using a study of eight biotech and pharmaceutical companies. Third, key challenges and opportunities are identified in the facilitation of radical pharmaceutical FEI through the existing HRM practices in the study. The following sections in this article begin with an identification of the concept of radical pharmaceutical FEI and an overview of the innovation-facilitating HRM practices identified in the literature. The results of the study are then discussed, which show how bundles of innovation-facilitating HRM practices are applied actively to enhance the level of radical FEI, but also the shortcomings of existing applications of HRM practices and key opportunities and challenges of pharmaceutical FEI. The article concludes with

discussion of the generic challenges of radical pharmaceutical FEI together with the potentials for developing and applying HRM practices in new ways as part of the opportunities for future research.

RADICAL PHARMACEUTICAL FRONT-END INNOVATION

This section discusses the unique characteristics and challenges of pharmaceutical FEI. Pharmaceutical companies are experiencing increasing pressure to innovate while also being cost-effective, as drug development becomes riskier and more expensive (Kola, 2008; Stephan, 2012). Combined with the unique characteristics and innovation challenges of pharmaceutical innovation, this stresses the need for innovation-supportive practices (Duyck, 2003). The characteristics of the pharmaceutical research process and FEI differ in several areas from FEI as carried out in other (non-science-driven) industries. These unique differences also render it difficult and non-viable to apply generic innovation management research and solutions in a pharmaceutical context (Aagaard, 2015; Duyck and Allen, 2006; Elmquist and Segrestin, 2007; Trotter, 2011). For one, pharmaceutical innovation is highly expensive and risky. Technical uncertainty is greater in science-driven innovation in health-related industries (compared to non-science-driven innovations) due to the unpredictability of biological systems and the extensive performance testing typically performed in laboratory assays and preclinical in vitro and in vivo models (Trotter, 2011). However, these models are not always predictive of product performance, biocompatibility, and safety in the human body (Rodriguez et al., 2010). In practice, this implies that a newly-discovered therapeutic agent with “blockbuster potential” still faces more than a 90% risk of failure during the development phase (Duyck, 2003). Furthermore, a report published by the Center for the Study of Drug Development at Tufts University (DiMasi, 2014; DiMasi, Grabowski, and Hansen, 2015) estimates the cost of developing a prescription drug that gains market approval at \$2.6 billion, which is a 145% increase (correcting for inflation) over the estimate they made in 2003. In summary, then, the technical, competitive, and regulatory risks are critical in this industry. The pharmaceutical industry has long been criticized for

emphasizing “me-too” products over radical innovations (Aagaard, 2015; Herson, 2005; Kola, 2008; PWC, 2007; Schmid and Smith, 2005). This is evidenced by arguments that incremental innovations should be priced at lower rates than those paid for breakthrough innovations (Coombs and Metcalfe, 2002). Yet we still see billions in capital form around making drugs. How can this be? As great as the technical and regulatory risks are, the market risk is very small. Epidemiologically speaking, we know years in advance how many people will have a particular disease. This reduction of market risk is unique to this industry and the reason why so much capital still forms around pharma and biotech despite the challenges.

Another key difference relates to how pharmaceutical innovation is science-driven as opposed to being customer-driven. This difference is explained in an empirical study by Bröring, Cloutier, and Leker (2006) emphasizing how the front end of technology-intense pharmaceutical R&D projects is driven by new scientific knowledge (as most ideas emerge from science), whereas the front end of consumer-focused companies is often purely market-driven. The study indicates that customer involvement is of less importance to the facilitation of radical pharmaceutical and biotech FEI, although needs derived from large-scale population statistics influence the general focus of pharmaceutical R&D. The duration of the pharmaceutical R&D process also exceeds that of most other industries. Pharmaceutical FEI, which is also referred to as the early research and preclinical phase, lasts up to 3.5 years, whereas the entire R&D process includes a number of sub-phases and often stretches out over 10–12 years (Sternitzke, 2010), as illustrated in Table 1 below.

Table 1. Overview of the pharmaceutical R&D process

Pharmaceutical R&D is highly controlled and regulated by external authorities, such as the American Food and Drug Administration (FDA), which require the comprehensive documentation, testing, and screening of any drugs that are likely to be introduced to the American market (PWC, 2007). The

FDA has documented pharmaceutical innovation since 1939, which provides considerable amounts of knowledge regarding the level of innovation of pharmaceutical products launched over time. However, the classification of innovation level differs between pharma and other industries. The FDA classifies marketing applications for new drugs according to the perceived therapeutic improvements of the drug and categorizes applications as “Class A” (high therapeutic improvement similar to radical innovation) through to “Class C” (little therapeutic improvement similar to incremental innovation). New medical products are classified in the approval phase on the following two dimensions: chemical combination and therapeutic potential.

The chemical combination is classified on the (new) molecular entities (NMEs) or (“update” of) medical components, which are based on new formulas or new applications of existing formulas but can be regarded as an update (Sorescu, Chandy, and Prabhu, 2003). The therapeutic potential of the product is evaluated in terms of whether it is a “priority review drug” (i.e., a medical product representing a therapeutic potential beyond existing products), whereas a standard review product has the same level of therapeutic quality as existing products on the market. Table 2 summarizes an industry-wide-accepted approach applied by the FDA for determining incremental and radical pharmaceutical innovation. This approach also relates well to the first two criteria in the radical innovation definition by Leifer et al. (2000) as presented at the beginning of this section (Aagaard and Gertsen, 2011). Thus, in this context and in Table 2, radical pharmaceutical innovation is represented by NMEs, and radical FEI may be explained as NME research projects/project ideas.

Table 2: FDA definitions of incremental and radical innovation

This section has emphasized the unique characteristics and challenges of pharmaceutical FEI as radical FEI is a necessity for the continuous performance and survival of pharma, just like many other industries (Aagaard and Gertsen, 2011; McDermott and O’Connor, 2002; McLaughlin, Bessant, and

Smart, 2008). In the next section, a theoretical overview and discussion of HRM practices in support of pharmaceutical FEI are presented as regards the unique characteristics and challenges of radical pharmaceutical FEI.

BUNDLES OF HRM PRACTICES IN SUPPORT OF RADICAL FEI

This section presents key bundles of innovation-supportive HRM practices as addressed in the innovation/HRM research and related to the specific challenges of radical pharmaceutical FEI. In the exploration of HRM practices supporting radical FEI, the literature identifies several HRM practices. In the theoretical review of these HRM practices, a selection was necessary, where the most researched and often-cited practices were emphasized together with the HRM practices addressed by the informants in the study. It appeared as though HRM practices and their ability to support innovation are difficult to isolate, since bundles of HRM practices are often applied to influence innovation in practice and HR practices influence one another (Aagaard and Andersen, 2015; Bowen and Ostroff, 2004). As stressed in the introduction, one key difference between pharmaceutical research/FEI and FEI in most other industries is that it is science-driven, not customer-driven. This implies that the primary emphasis of pharmaceutical FEI/research is on scientific knowledge and employee competences as opposed to customers and markets. HRM might therefore play a key role in supporting the knowledge resources for radical pharmaceutical FEI through, for example:

- 1) Recruitment of highly skilled scientists
- 2) Training of innovative teams
- 3) Innovation leadership/management and an explorative culture that supports and motivates radical, science-driven innovation
- 4) Talent and performance measurement that can ensure the right competences and a continuous innovation push and performance throughout the 10–12-year pharmaceutical R&D process.

Nishii, Lepak, and Schneider (2008) note that: “It is not just the HR practices themselves, but rather also employees’ perceptions of those HR practices that are important for achieving desired organizational outcomes” (p. 528). This adds another dimension to the analysis—a more attitudinal dimension compared to the behavioral. It is therefore not enough to uncover the existence of bundles of practices in companies; one must also identify how they work and how the employees’ perceive them in the implementation.

The following sections provide a theoretical overview of key innovation-supportive HRM practices as regards the identified characteristics and challenges of radical pharmaceutical FEI.

HRM PRACTICES IN THE RECRUITMENT AND SELECTION OF INNOVATIVE SCIENTISTS

Science-driven and knowledge-intensive industries like the pharmaceutical and biotech industries emphasize the need to hire and select highly skilled scientific profiles, since the knowledge and unique competences of the employees are the primary input in science-driven innovation. Staffing is considered a key HRM practice for pharmaceutical innovation and includes access to external sources of recruitment (Raghuram and Arvey, 1994), the selection of employees based on their polyvalent skills (Gupta and Singhal, 1993), and organizational culture fit (Jones and Sullivan, 1994). In pharma and biotech, recruitment becomes a key innovation factor, as unique scientific profiles, networks, and expertise areas are in demand in the facilitation of radical pharmaceutical research/FEI. A broad range of people and ideas is the basis for creativity and FEI in the initial phases of the innovation process (DeCusatis, 2008).

The human aspect of innovation is initially based on selecting not only appropriately skilled employees, but also individuals with attitudes that support knowledge sharing (de Winne and Sels, 2010). Thus, staffing should also search for profiles with the right networking skills and global scientific network in support of their research. Shadur and Snell (2002) emphasize that HR practices

can play a role in stimulating innovation by sustaining processes of knowledge creation, transfer, and integration. All this is done for the purpose of obtaining self-confident, risk-adaptive, and involved employees who favor radical innovation (Al-Laham, Tzabbar, and Amburgey, 2011; Jiménez-Jiménez and Sanz-Valle, 2008).

HRM PRACTICES IN TRAINING OF INNOVATIVE TEAMS

Training and competence development that contributes to performance and knowledge creation processes is key to knowledge-intensive FEI as in pharmaceutical research (Valle, Martin, Romero, and Dolan, 2000; Walsworth and Verma, 2007; de Winne and Sels, 2010). Innovation depends on knowledge exchange and training enhances the transfer of knowledge (Sparkes and Miyake, 2000), which is a key element in the facilitation of radical pharmaceutical FEI, as the use of cross-functional R&D teams is a basic organizing principle in pharmaceutical and biotech research. Several studies have revealed how cross-functional teamwork plays an important part in eliciting innovation (see Barczak, Lassk, and Mulki, 2010; Cabrales, Cabello, Carmona, and Valle, 2008; Kratzer, Leenders, and van Engelen, 2005; Ledford, Lawler, and Mohrman, 1995; Leede, de Looise, and Alders, 2002; McDonough, 2000; Norrgren and Schaller, 1999; Stock, Totzauer, and Zacharias, 2014). The cross-functional R&D cooperation (i.e., the extent to which members of the R&D function interact and share valuable information with other functions) (Isaksen and Lauer, 2002; Song, Thieme, and Xie, 1998;), increases both innovativeness (De Clercq, Thongpapanl, and Dimov, 2011; Sethi, 2000; Sethi, Smith, and Park, 2001; Sherman, Berkowitz, and Souder, 2005) and new product performance (Kahn and Mentzer, 1998; Leenders and Wierenga, 2002; Song and Song, 2010).

In this context, team cooperation, communication, and conflict resolution are critical dimensions in R&D teams with an innovation expectation as in radical pharmaceutical research processes (Barczak and McDonough, 2003; Beer and Eisenstat, 2000). But how can a pharmaceutical company support

radical FEI through training? Based on a sample of 95 companies from four innovative industries, Cabrales, Cabello, Carmona, and Valle (2008) found that team diversity and the combined use of long-term and short-term incentives are associated with incremental innovation, whereas the development of risk-taking attitudes in a team is associated with radical innovation.

HRM PRACTICES SUPPORTING INNOVATIVE CULTURE & LEADERSHIP

While incremental innovations appear to depend on traditional management structures and processes (Ettlie, Bridges, and O'Keefe, 1984), radical innovation can demand an organizational response that reaches beyond the "steady-state" approach to managing innovation (McDermott and O'Connor, 2002). Radical innovations often apply disruptive technologies and so require a different set of rules for managing the innovation process (Hill and Rothaermel, 2003), where the applied leadership style becomes a key factor in facilitating radical FEI (McDonough and Barczak, 1991). The relationship between leadership and innovativeness has been investigated by various disciplines, such as *management* (Elenkov, Judge, and Wright, 2005; Jung, Chow, and Wu, 2003; Keupp, Palmié, and Gassmann, 2011; Valencia, Valle, and Jiménez-Jiménez, 2010), *marketing and innovation* (Gumusluoğlu and Ilsev, 2009; Stock and Zacharias, 2011), and *psychology* (Eisenbeiss, van Knippenberg, and Boerner, 2008; Lee, 2008). The research into the impact of leadership on innovativeness has identified positive direct effects (e.g., Gumusluoğlu and Ilsev, 2009; Jansen, Vera, and Crossan, 2009) and indirect effects through organizational learning (García-Morales, Jiménez-Barrionuevo, and Gutiérrez-Gutiérrez, 2012) as well as increased empowerment and support for innovation (Jung, Chow, and Wu, 2003). The latter effect is particularly interesting in relation to radical pharmaceutical FEI, as the lengthy duration of the pharmaceutical R&D process requires scientists to be both self-motivating and self-managing; empowerment is therefore suggested as being central to successful pharmaceutical FEI.

Several empirical studies have examined the link between empowerment and innovation. Mazzanti, Pini, and Tortia (2006) are among those who have found that a good industrial relations environment and employee involvement stimulate organizational innovation. Tsai's (2006) study of the semiconductor design industry in Taiwan revealed how the effective use of employee empowerment practices positively relates to innovation. Zeffane and Al Zarooni (2012) showed that both empowerment and trust have an impact on commitment and performance. Von Stamm (2003, p. 260) emphasizes that "radical ideas tend to need room to grow and develop, they tend to change shape and scope." Thus, an organizational culture that supports radical innovation tends to be tolerant of risk-taking and the uncertainty that facilitates this type of innovation (Claver, Llopis, and Molina, 1998; Martins and Terblanche, 2003). In the study by Tellis, Prabhu, and Chandy (2009) covering 759 firms across 17 major economies, corporate culture was the strongest driver of radical innovation. McLaughlin, Bessant, and Smart (2008, p. 306) identified nine key emerging themes supporting radical innovation: Freedom/latitude, attitude to risk, growth/development, external confidence, external perspective, clear objectives, team constitution, and company infrastructure. In radical FEI in particular, developing a continuously investigating and questioning attitude among employees is central (i.e., cultural values of growth and development leading to innovation) (Miron, Erez, and Naveh, 2004; Schein, 2004; West, 2002). Numerous authors also stress how HR can play a key role in facilitating innovation culture (Guest, 1997; Lau and Ngo, 2004; De Leede and Looise, 2005; Mazzanti, Pini and Tortia, 2006; De Winne and Sels, 2010).

HRM PRACTICES SUPPORTING TALENT & PERFORMANCE MANAGEMENT

Nurturing talents and champions is a key element in carrying out radical pharmaceutical FEI, as R&D projects need champions to "push" and support them through lengthy R&D processes (Aagaard and Gertsen, 2011; Jenssen and Jørgensen, 2004; Markham and Griffin, 1998). Since the late 1990s, talent management literature has rested on the assumption that knowledge is created

by and stored within individuals (Grant, 1997). However, a growing body of literature emphasizes that classical resources alone are rarely a source of competitive advantage (e.g., Cappelli, 2008; Ray, Barney, and Muhanna, 2004). This also goes for radical pharmaceutical FEI, which is created in cross-functional research teams. Talent and performance management are central elements of supporting innovation (Poskela and Martinsuo, 2009; Salomo, Weise, and Gemünden, 2007; Sarin and Mahajan, 2001). Innovation literature on performance management has either implicitly or explicitly focused on rewards, recognition, and acknowledgement as drivers for innovative behavior (e.g., Bae et al., 2003; Guest, 1997; Hauser, 1998; Martinsuo and Poskela, 2011; Poskela and Martinsuo, 2009; Sarin and Mahajan, 2001; Searle and Ball, 2003; Yanadori and Cui, 2014). However, Pfeffer and Langton (1993) found that large pay differentials increase the competitive tension among employees and discourage employee collaboration and cooperation, which is highly detrimental to FEI, as idea generation often involves collaboration among employees (Collins and Smith, 2006). Large pay dispersion allows pharmaceutical firms to attract star researchers, yet the lack of commitment from non-star researchers prevents the firm from capitalizing on star researchers' knowledge in order to generate innovation (Rothaermel and Hess, 2007). It is therefore imperative that pharmaceutical companies identify the need to develop holistic yet informal assessment systems and managerial work that proactively reduce the risks associated with complexity (Martinsuo and Poskela, 2011) and apply team-based appraisal followed by performance pay that can help steer employee behavior in the desired "creative or innovative" direction, reinforcing mutual goals and cooperation (Cabrera and Cabrera, 2003). In summary, then, the theoretical overview of innovation-supportive bundles of HRM practices to be explored empirically in the context of radical pharmaceutical FEI is presented in Model 1 below.

Model 1: A theoretical overview of the key bundles of HRM practices supportive of radical FEI

METHODOLOGY

A case study design was selected in order to explore how radical pharmaceutical FEI can be facilitated through the application of innovation-facilitating bundles of HRM practices in a real-life pharmaceutical and biotech context. An exploratory case study approach was chosen to ensure a methodological fit between the research question and the status of prior theory (Edmondson and McManus, 2007). Case study methodology is suitable for acquiring rich and detailed data (Eisenhardt and Graebner, 2007; Yin, 2003) and for identifying emerging themes and patterns (Eisenhardt, 1989). It is also appropriate for creating new knowledge on how and why events occur in situations with little theoretical background (McCutcheon and Meredith, 1993), as is the case of HRM practices in support of radical pharmaceutical FEI.

The current study incorporates an in-depth case study of Company A and validation studies from seven other companies, referred to as Company B–H. This approach is particularly relevant for testing conclusions through replication (Yin, 2003) and for providing a larger picture of a complex phenomenon (Stake, 1995). The applied design strategy helps explain the causal links in real-life situations that are too complex for a single survey or experiment (Yin, 2003). Furthermore, undertaking case studies and validation studies can generate explanations and test them systematically, which adds to the validity and generalizability of the findings (Miles and Huberman, 1994) through replication logic (Eisenhardt, 1989; Yin, 2003). The applied analysis method incorporates both within-case analysis of the single company and comparisons between companies, “as most case studies involve both kinds of analysis due to the limits of either method used alone” (Bennett, 2004, p. 21).

In the validation and elaboration of the findings from the case study of Company A, validation studies were conducted among seven selected case companies B–H. This specific approach is applied to increase construct validity and to explore the concept across the industrial context of the study. By replicating the case using pattern-matching techniques (Yin, 2003), multiple items of information from

the same case are linked to other cases and theoretical propositions. This design can therefore help enhance and support the previous results. This approach raises the level of confidence in the robustness of the method and the findings of the study (Campbell, 1975).

A key objective of this study has been to explore the demand side of innovation-supporting HRM practices rather than the supply side. The rationale behind asking the research personnel (and not the HR division) about the demand of HRM activities relates to the objective of studying how pharma and biotech research divisions can apply HRM practices actively in supporting radical, science-driven FEI—not which HR practices the HR division supplies or how the HR division experiences their own HRM practices.

Case selection

The eight companies (A–H) were selected based on their characteristics, and their situation at the time of the study represented the challenges faced by many established medium- to large-sized biotech and pharmaceutical companies in terms of remaining innovative and flexible. The following criteria were applied in selecting the specific companies:

1. Pharmaceutical and/or biotech companies
2. Medium- and large-sized companies
3. European- and/or American-based companies.

The reason for the first criterion and the combination of the two industries (pharma and biotech) relates to the similarities in R&D personnel in the two, as many scientists work across both industries and some of the larger companies include both biotech and pharmaceutical research and product offerings. The second criterion ensures that the company size differs among the selected case companies, as the study wanted to challenge the speculation or hypothesis that larger pharmaceutical and biotech organizations are equipped with large HRM departments that support radical research/FEI more or differently than smaller and medium-sized companies. The third criterion relates to the fact

that existing research on pharmaceutical FEI is primarily based on European and American companies, as they have dominated the pharmaceutical market for the last decades. This picture is changing, however, as Asian pharmaceuticals are growing stronger, so further research includes the potentials of including Asian case companies.

Table 3: Overview of companies and respondents in the study

Data collection and data analysis

A case study of Company A was carried out over a three-year period, which allowed for an in-depth study of the facilitation of radical pharmaceutical FEI. The data was collected through documentation, informal observations, and 80 qualitative, semi-structured interviews with senior research managers, project managers, and lab scientists in research, representing the employees responsible for FEI/research in the Danish and American research divisions. The interviews were designed to examine the differences between HRM practices and how they could be applied to support and facilitate radical pharmaceutical FEI. In the actual interview sessions, radical FEI was initially explained to the informants as research projects for NMEs, since this is the industry-wide accepted terminology of radical innovation, as presented by the FDA. In the study of innovation-supportive HRM practices in support of radical pharmaceutical FEI, the same interview guide was used for all eight companies (A–H) to explore the following three key questions:

- 1. How can HRM practices be applied in the active facilitation of radical front-end innovation across the research divisions?*
- 2. How does research/FEI experience the application of HRM practices in the facilitation of radical research/FEI?*
- 3. What are the key challenges and opportunities related to the use of HRM practices in the facilitation of radical pharmaceutical FEI?*

The methodological choice of interviewing informants, at the tactical and operational levels in addition to the management/strategic level was deliberate. Managers typically implement HR practices yet they seldom experience the practices themselves or the daily effects. By also interviewing scientists and lab technicians, the operational facilitation of FEI through HR practices as experienced by the employees was also included in the study to ensure a broader scope of what active facilitation of radical FEI through HR practices entails in practice and at all organizational levels. The findings from the in-depth single-case study of Company A provided nine categories of meaning for how HR practices could assist radical FEI/research as perceived by the informants: 1) Enabling innovation culture, 2) Supporting innovation management, 3) Communicating about innovation, 4) Supporting innovative teams, 5) Supporting innovative individuals, 6) Recruiting innovative talents, 7) Facilitating training to build innovation capacity, 8) Managing talents, and 9) Measuring performance and applied types of appraisal.

To validate and further elaborate on the findings from the case study of Company A, validation studies were conducted among seven selected European and US pharmaceutical and biotech companies (Companies B–H, see appendix). The reason for this approach relates to the unique benefits from cross-case analysis that can mobilize knowledge from individual case studies. Mobilization of case knowledge occurs when researchers accumulate case knowledge, compare and contrast cases, and in so doing produce new knowledge (Khan and VanWynsberghe, 2008). The comparative cross-case study followed the same methodological approach and applied the exact same interview guide while interviewing two–three key research personnel in charge of FEI/the research process in each of the seven validation studies. In addition to increasing the validity and reliability of the findings, this comparative approach was also used to explore the results across a larger industrial context for a generalization of the pharmaceutical industry.

The interview sessions and conversations were recorded and subsequently transcribed and approved by the interviewees before being synthesized into the frame of a case. Some of the interviews were translated from Danish to English. The analysis of the interviews was carried out by applying pattern matching using the contemporary “meaning categorization,” data processing and data analysis method, meaning that similar statements from the interviews were coded into categories (Kvale and Brinkman, 2008). In the data analysis process, meaning categories and subcategories were only established if all eight companies (A–H) had addressed and quoted at least one element related to the category. As part of the cross-case analysis, a prioritization of the meaning categories across the eight companies was conducted. The nine most prioritized meaning categories of each of the eight companies were then selected and combined to map the meaning categories from the highest priority (1) to the lowest (9), thereby giving the same weight of priority to all eight companies not depending on the number of interviews or quotes from each case company. This approach was applied to avoid meaning categories only being formed on Company A informants’ responses, as this main case constituted 80 out of the total of 97 interviews and could therefore have presented a bias if the approach was not integrated in forming the meaning categories. The meaning categories capture the overall categories of more generic innovation-supportive HRM practices, whereas the subcategories constitute the categories of the specific innovation-supportive HRM practices applied by all eight case companies. In the next section, the findings and meaning categories for how HRM practices are applied in supporting radical pharmaceutical FEI across the eight companies are presented in Table 4 and later discussed in the “Findings” section. Subsequently, the key challenges and opportunities in applying HRM practices in support of radical pharmaceutical FEI are identified and presented.

FINDINGS

It became apparent in the analysis that HRM practices are applied actively to support more explorative and radical research/FEI in the eight pharmaceutical and biotech companies, as explained

in the following sections. The derived findings from the 97 interviews were categorized by type of innovation-enabling HRM practices applied in support of radical FEI. The nine meaning categories and 29 related subcategories that are explained in detail in the subsections below, are presented in table 4.

Table 4: Categories of HRM practices supporting radical pharmaceutical FEI

As often investigated and presented in the innovation/HRM literature, *enabling innovation culture* was the one HRM practice that was addressed by most respondents, but not in general terms. One very critical and generic innovation challenge of pharma, which was stressed by a majority of the respondents, relates to the enormous costs of failing (e.g., mass trials and lawsuits from negative medical effects). This fear of failure was an integrated phenomenon across the companies interviewed; the respondents used terms like “zero-error culture” and “risk-averse innovation culture,” all of which stressed a blame-free, explorative innovation culture. In minimizing this inherent culture, the emphasis of the applied HRM practices was on: “A culture eager to learn” (stated by a project manager, Company E); “a blame-free culture” (emphasized by a lab technician, Company A); “not just picking the low-hanging fruits” (stressed by a research manager, Company B); “developing a calculated risk-taking culture” (emphasized by a research director, Company D); and “stressing more exploration than exploitation of potentials” (identified by a senior scientist, Company F). “In molding a more explorative, not risk-free, but calculated risk-taking culture,” as emphasized by the research vice president of Company A, several HRM activities and channels were applied. These included storytelling and communication on exploration and learning through failure, corporate value and innovation strategy processes (emphasizing exploration), tools and management training in supporting more exploration and diversity in project teams, and specific project objectives stressing exploration. In Company A, the management and scientists addressed the concept of “calculated risk” in research projects, and a concept called “the learning of the week” was

introduced and celebrated in projects to emphasize the need to be explorative and take calculated risks in effectively supporting more radical approaches and ideas in research.

Supporting innovation management and leadership was the meaning category receiving the second highest emphasis by the respondents and their specific comments. The generic characteristics of the 10–12-year long pharmaceutical R&D process stresses high efficiency and speed due to heavy investments emphasized by the extensive usage of stage-gate models, as underlined by the respondents from all eight companies. When innovations do not present documented and improved solutions to the market, however, they will not earn patenting rights from the FDA or ensure the necessary competitive advantages on an extremely competitive global market. “It is therefore necessary to lift the bar of research and not just ‘cruise’ fast through the stage-gate model,” as a senior scientist at Company H commented. This innovation challenge emphasizes the need for both HRM and management to support a learning-based innovation culture that aims at exploring new medical territories but still operates within calculated risks, the strict timelines, yet without spending time on blame if the innovation quest goes wrong. However, pharma is challenged by one critical policy issue that influences the innovation management of the entire industry, which is beyond the scope of HRM, as emphasized in this statement by a Company E project manager: “At present, the FDA and other agencies do not grant longer patenting rights for radical new invention compared to incremental product improvements [...] So what is really the incentive for this industry in pursuing truly radical new innovations?” This statement stresses a serious problem in how the present policy and legislation may potentially reduce the initiative to go the extra mile for NMEs and radical innovations.

Communicating about innovation was the third highest ranked meaning category of innovation-supportive HRM practices applied to facilitate radical research. Several of the research managers

and directors interviewed had drawn on assistance from their HRM divisions in corporate value integration processes and in specific “innovation communications” and “innovation theme activities,” which may be considered “innovation culture supporting activities.” A scientist at Company D noted that: “Our HRM department has in collaboration with Corporate Communications played a key role in storytelling about radical research carried out by our key champions.” In Company E, a research director stressed: “We need to tell the good stories from everyday research activities to support the type of innovation that we want our employees to pursue.” In Company A, a senior scientist emphasized how the HRM department helped the research department carry out an innovation strategy process and an innovation kickoff to start a new tradition of putting radical research ideas on the table.

Supporting innovative teams and individuals/champions received almost the same level of attention among the respondents. Pharmaceutical FEI requires close collaboration across the different scientific disciplines, and regular knowledge sharing is therefore imperative to successful research. This element was also stressed in a statement made by a Company H research director: “Cross-disciplinary collaboration and knowledge sharing are even more important in explorative research projects, as these projects require more trial and error [...] HR can help ensure the right profiles in the research teams but also help facilitate joint activities.” Although radical pharmaceutical FEI is carried out in teams, the role of the champion is critical to success, as someone must champion the research project through the trials and challenges that the project will encounter. A research director from Company E addressed this issue: “Radical ideas for research projects cannot survive without a champion [...] This is also why recruiting, nurturing, and praising innovative talent is key to pharmaceutical success.”

Recruiting innovative talents that can develop the next patented blockbuster drug and thereby ensure the company’s future in the coming years is a vital HRM task. The findings showed that all eight

pharmaceutical and biotech companies operated globally and had a global research staff of various biotech and pharma backgrounds. This finding is not surprising in that the industry is renowned for being global in its mindset, since creating drugs exclusively for national markets is simply not financially viable. In the gathering of data on how recruitment and team organization were applied to support FEI, an interesting finding emerged: It became apparent that senior scientist recruitments primarily went through the networks and references of the research divisions and personnel. Furthermore, only pharma and biotech profiles were requested. This apparently has a negative effect on the level of group thinking and team diversity, as stressed by several respondents at operational, tactical, and strategic levels across all eight companies. One senior scientist from Company C emphasized that: “We all have very similar backgrounds and profiles, which is great for joint agreement and efficiency, but not so good for challenging each other to go beyond our scientific comfort zones.” Likewise, a project manager from Company D pointed out that: “We think way too much alike.” Upon presenting these findings to the companies, a research director from Company A replied: “You have to remember that we (i.e., the pharmaceutical scientists) all go to the same conferences and we’re more or less educated in the same places and moving to and between the same companies. So we share a number of similarities and probably think very much alike when it comes to innovation and how to develop a new drug.” This aspect of “thinking alike” is great for efficiency and speed in the pharmaceutical stage-gate research process but less potent in creating team diversity, as stressed as a prerequisite for radical innovation in the literature. In Company A, HRM activities were set in motion to select and recruit personnel outside of pharma to ensure more diversity in terms of how various processes had previously been carried out (e.g., patenting, talent management, communications). Furthermore, team rules were established to ensure that the same team members were not put together repeatedly. The positive side effects were the better integration of junior scientists and better collaboration across the three research divisions of Company A. HRM could play a central role in challenging this industrial inertia by going beyond the existing and

internally formed networks, the usual channels of recruitment, and the typical pharmaceutical employee profiles.

Facilitating training to build innovative capacity and ensuring the proper training and the right competences to perform groundbreaking pharmaceutical and biotech FEI/research is central to HRM. In exploring how the HRM practices related to training were applied in supporting radical pharmaceutical FEI, a general thesis confirmed that the younger the (research) personnel, the more training and development activities were applied. On the other hand, senior research personnel primarily attended conferences and participated less in training and development activities. This finding might not be surprising, as the anticipated explanation would be that the higher the level of seniority, the more knowledgeable and competent you are, and, therefore, development activities are not necessary to perform your research/job. However, this was not the case when elaborating on the observation above.

It became apparent that the majority of respondents with higher levels of seniority did not require and participate in courses and development activities due to the fact that they considered the available courses much too generic and not specific enough for them to gain access to the necessary knowledge and competences. One senior scientist from Company G explained: “If you want to stay ahead of the competition, then you have to be better than the rest [...] Going to the same courses and generic education modules will not teach you anything new—they’ll only repeat what you already know and what everybody else knows.” A research manager from Company C replied: “I never use HR when I have to develop my senior scientists [...] The training and courses are much too generic for them to learn what they need.” One challenge of HRM identified from the different statements seems to be that their training practices overemphasize generic training modules versus specialized and individualized training. A research director at Company A also addressed this issue: “HRM could

take on a much bigger role in tailoring specialized training modules but that would require closer collaboration with the scientific disciplines in mapping what is really requested.”

“Managing talents” and *“Measuring performance and applied types of appraisal”* were the two meaning categories receiving the fewest comments from the respondents, although still considered central activities in HRM’s support of radical pharmaceutical research. Throughout the case study, the number of similarities versus differences across the applied HRM practices supporting radical FEI revealed a surprisingly homogeneous industry; a finding supported by previous respondent statements. However, two HRM practices were pursued very differently among the companies, as elaborated below.

Managing talents

The differences in the talent management approaches applied were explained “as a tool for attracting and retaining key personnel” by a research director (Company A) and as “a competitive tool” by another research director (Company B). The findings revealed that the largest companies in the study all had well-established talent management programs that were supported by HRM academies, supplying them with everything from personal coaching to exclusive management development programs. In contrast, the smallest of the companies (Company H) applied a more personal approach, the director stressing that “as senior scientists, we take the younger talents under our wings to provide them with a more individualized talent management approach.” This approach specifically included personal sparring and access to their key contacts and networks as part of their talent development. HR’s involvement in talent management was quite visible, since the larger companies in particular applied their extensive HRM academies as a platform for their talent management development activities. Conversely, the smallest companies relied more on senior scientists to tailor and carry out the necessary training, development, and nurturing of talent, as they

did not have HRM academies to take care of such activities. These formal as well as informal talent management programs were supplemented by performance measurement and appraisal systems driving the “preferred” research behavior and results. The applied bonus systems/packages of the companies included financial bonuses, employee shares, free health and dental care (primarily the US-based companies), and an extra week of vacation.

Measuring performance and applied types of appraisal

Innovation performance was also measured differently, although project measurement in terms of meeting deadlines and budgets was common across all eight companies. Here, a research director from Company G explains another measurement of innovation performance shared by all eight companies in the study: “We monitor the publication records—they need to be at the forefront scientifically.” The differences in performance measurement related to how the more radical innovation was nurtured and measured. In the smallest of the companies (Company H), the research management had integrated free time for so-called “blue sky” research (explorative, radical innovation), and their performance measures also stressed the employees’ abilities and performance in relation to generating ideas for new projects, radical discoveries, and new product performances rather than just meeting the project objectives. Interestingly enough, the smaller companies in the study emphasized innovative FEI through more “creative” performance measures (e.g., application of new animal models, different screening techniques), whereas the largest and primarily American companies in the study stressed quantitative project objectives the most. However, the challenges of measuring too vividly were also stressed by a research director (Company C): “Too many reviews and communities kills innovation [...] Reviews shouldn’t be held too often [...] we say every 9–12 months, not more often than that.”

Performance measurement was primarily set up by the research divisions and carried out together with HRM. Again, a more quantitative performance measurement approach was applied by the

largest of the companies in the study, whereas the smallest companies also emphasized qualitative measures and evaluations in their performance measurement. One possible preliminary conclusion is therefore that HRM might have an immediate advantage in supporting radical FEI through talent management and performance measurement, as it possess core knowledge about what motivates employees and can assist R&D in designing the optimal performance measurement, appraisal systems, and talent management programs to emphasize innovative profiles. Moreover, these HRM practices are what set the companies in the study apart and have provided them with competitive advantages in recruiting new talents and retaining existing talents. The key findings from the study of HRM practices in support of radical research/FEI are summarized below and in Model 2.

HRM's opportunities and challenges in supporting radical pharmaceutical FEI

The study did not just reveal positive experiences of HRM in active support and facilitation of radical pharmaceutical research. In further elaboration of why the HR division was not included more in innovative types of activities, a lack of HRM integration was revealed. Several respondents stressed that the HR division was not asked to participate in the HR-related practices addressed earlier due to their lack of knowledge about science, the research challenges, and/or the business aspects of the company. One senior scientist from Company D even stated: "They're great at kick-offs and employee events but have no clue about what we're doing." This finding was not exclusive to Company D, as 16 of the 80 respondents across the eight companies in the study stressed the problem of HRM not understanding pharmaceutical research and science. As such, this may imply the need for more in-depth research and business knowledge among the HR divisions in gaining the trust of research personnel to be "allowed" to participate in supporting radical research more effectively through targeted HRM practices.

The document study of training catalogues from the eight companies as part of the data collection process proved the points made by the respondents. Yet it also made a clear statement about training

in science-driven, knowledge-intensive industries like pharma and biotech being a challenge to HRM, as it requires targeted training tailored to the specific scientific competence needed. One respondent, a research assistant at Company A, commented on how: “We have a huge catalogue of training and courses from which to choose.” A project manager from Company E said: “There’s a great selection of more generic project management courses, but none of them quite capture the challenges I experience in running a scientific research project over a period of eight years with new project members coming and going.” Thus, if HRM does not have sufficient knowledge about the research process or the pharmaceutical business process, as suggested previously by the respondents, then they might be unable to ask the right questions to identify and develop the proper training and development activities in support of the company’s radical FEI/research. This indeed poses a real challenge to HRM. Management training was raised frequently in the interviews, which could have been due to the large percentage of top management participation (34 out of 80) in the study. However, the request for more innovation management tools and training as well as innovation managers as role models came largely from respondents at the tactical and operational levels of the research divisions of the companies in the study—and only to a limited extent from top management respondents. Training senior research directors is no easy task, however, as underlined in the following statement by a research manager (Company A): “I’ve been in the game for over 25 years, and it’s hard to teach an old dog new tricks.” Another research manager (Company H) stressed: “I stay ahead by constantly searching for new knowledge, and the venues for this are research, networks, and conferences—not training courses.”

Model 2 summarizes the findings of key HRM practices in support of radical pharmaceutical FEI, as identified in the study. The order/priority by which the identified innovation-supportive HRM practices are presented in the table is not random. The number of comments provided for each meaning category provides a clear indication of which HRM practices the informants perceive and experience to have the most significant support of and effect on radical pharmaceutical FEI. It starts

from the bottom, with the fundamental and most important innovation-supportive HRM practices, and ends at the top with the practices emphasized the least by the informants. The innovation foundation of the company (innovation culture, leadership) was particularly emphasized as critical in the pursuit of radical pharmaceutical research/FEI, as addressed, for instance, by a research director from Company A: “You can have all the systems and processes in the world, but it all starts with the right innovation culture and innovation leadership.”

Model 2: Summary of the study findings

DISCUSSION

In answering the research question: “How are innovation-facilitating bundles of HRM practices applied to facilitate radical pharmaceutical FEI?”, a theoretical overview was first identified, constituting four bundles of key innovation-supportive HRM practices: recruitment/selection, training of innovative teams, innovation culture and leadership, and talent and performance management. Through an in-depth case study of Company A and seven validation studies (Companies B–H), the challenges of radical pharmaceutical FEI were captured, and the application of HRM practices in facilitation of radical pharmaceutical research/FEI was explored. Through the data analysis, nine generic meaning categorizations and 29 (specific) subcategories were identified, revealing generic and specific key HRM practices that can be applied in support of radical pharmaceutical research. Many of the HRM practices appeared to overlap and should be viewed as bundles of HRM practices. For example, innovation culture was facilitated through several HRM practices (e.g., through innovation communication and storytelling, the profile of employees being recruited, the way employees are combined in teams, the innovation strategy promoted, and how managers lead innovation), all of which also influenced each other. Thus, isolating HRM practices and their effect on innovative R&D were not viable and not an objective of this study.

Results

The case study findings emphasized that HRM may play an active role in supporting radical research/FEI. This is particularly true for HRM's facilitation of a blame-free, more risk-averse innovation culture and innovation leadership via innovation communication, radical research storytelling, innovation kick-offs, through innovation value and strategy processes, and through global and diverse recruitment, specialized training as well as talent and performance measurement supporting innovative champions. However, the findings did not provide any measurement of the performance effect from these HRM practices, as this would require a longitudinal study of 10–12 years, equal to the duration of the pharmaceutical R&D process and the opportunity to isolate the effect of HRM practices on radical pharmaceutical FEI/research from all other internal and external influences.

The findings also uncovered a number of key challenges and opportunities for HRM in supporting FEI. The complexity of this industry's business and science-driven research/FEI process renders it difficult for HRM to identify and tailor the necessary training and development, particularly at the senior level. The same challenge applies to the recruitment of diverse profiles, where HRM should play a much more prominent role, but HRM is not always invited. One conclusion could be that HRM divisions should invest more time in understanding the business and research side of their corporations to be able to support radical pharmaceutical FEI better and more effectively. This would also serve to help gain credibility and trust among R&D personnel when they are invited to join the development of these HRM practices in close collaboration and coordination with the specific divisions and their unique training and recruitment strategies. Specific challenges with existing HRM practices revealed that many of the training programs supplied were too generic (particularly for senior scientists), and that a lack of diversity in recruitment and team settings contributed to inertia and groupthink, which appeared to cause barriers to more explorative and

radical ideas beyond the existing project portfolio. The findings would appear to indicate that a serious and generic challenge to the entire industry is how recruitment and the selection of future talent takes place. The fact that employees go to the same universities and conferences and are hired by the same companies in the same industry highlights the challenge of this industry's inertia and lack of diversity. All of this may represent a threat to future radical pharmaceutical innovation, as the same knowledge is shared and repeated among the same people, and thus not challenged and/or disrupted by non-pharma employees.

Theoretical implications

The theoretical framework identified four bundles of innovation-supportive HRM practices of high importance to knowledge-intensive, science-driven FEI. The contribution of the research presented in this article extends the knowledge of the HRM–innovation relationship in general by focusing on KIFs like pharma and biotech companies, which is an area that has been largely unexplored despite calls for research in this area (Jackson, Chuang, Harden, and Jiang, 2006). Furthermore, these contributions to the innovation–HRM literature address the need to target innovation-supporting HRM practices to the specific requirements of the division and scientific discipline. This entails a much closer collaboration, dialogue, and more extensive understanding of the business that HRM is expected to assist. The innovation/HRM literature emphasizes generic HRM practices, where this study reveals that generic HRM activities will be unable to support radical FEI. A key contribution of this study constitutes the empirical exploration of generic innovation-supportive HRM practices in facilitation of radical FEI and in the specific industrial context of pharma. A number of studies emphasize the severe obstacles facing established firms when they engage in the development of breakthrough innovations (e.g. Christensen, 1997; Henderson, 1993; O'Connor and De Martino, 2006). As emphasized by O'Connor and De Martino (2006), the main challenge is that the typical internal organization of incumbents is designed to assure efficiency in daily operations,

which is at odds with the pursuit of breakthrough innovation. Big pharma consists of established firms that are facing this exact problem, which is why the article applies pharma as the industrial context in which to explore the aim of this special issue “Organizing for breakthrough innovation: Taking inspiration from the organization of science.”

Managerial implications

The managerial implications of these findings and contributions stress how management in pharmaceutical and biotech companies through specific innovation-supportive HRM practices can actively facilitate an organizational framework that more effectively support radical pharmaceutical research/FEI. Furthermore, the findings address the opportunities of R&D management in applying HRM specifically in relations to new recruitment and talent management strategies, emphasizing boundary-spanning competences instead of hiring within the circles of pharma. HRM can also play an active role in training managers, teams, and individuals/champions in disruptive/radical innovation processes and in forming and managing innovation/research teams with profiles that support radical ideation better. HRM can also help management establish talent and performance management systems that more effectively support and praise radical FEI and the profiles that excel in this area. The empirical contributions constitute the identification and discussion of how specific innovation-enabling HRM practices are applied to actively support explorative behavior and FEI in pharmaceutical companies. Another contribution lies in the identification of the experienced opportunities and challenges of applying HRM as a leverage of radical research/FEI in the context of the pharmaceutical and biotech industry. Finally, the derived results of the study also underline inherent industrial challenges of regulations (FDA) that stimulate more incremental innovation, which cannot be resolved by HRM and require the attention of policy-makers.

Limitations and future research

The study presents a number of limitations that also represent avenues for further research. For one thing, the theoretical review primarily focuses on four bundles of HRM practices in support of radical pharmaceutical and biotech FEI. As the literature and research within the fields of HRM and innovation are extensive, other categories may have been included. However, attempt was made to group and categorize the innovation/supportive HRM practices most frequently mentioned in HRM/innovation literature, which could also relate to the specific challenges of radical pharmaceutical FEI. The objective of this case study has been to examine radical FEI in the specific industrial context of pharma and the role of HRM practices in support of this. A key contribution is therefore also related to the empirical context in which radical FEI support is explored. This may be considered a limitation, as the results should not be generalized to industries that do not have the same FEI characteristics and challenges as pharma.

A limitation of the study stresses that the HRM practices identified in the case study only represent what the representatives of research divisions in the eight pharmaceutical companies perceive and experience to have a positive effect on radical FEI/research. However, it was not viable to carry out a longitudinal study to measure the actual innovation effects of these HRM practices at the end of a 10–12-year R&D process. Thus, a longitudinal study of the measured effects of applying innovation-supportive HRM practices in active facilitation of radical pharmaceutical FEI would be a possible theme for further research. Another limitation may relate to the fact that all eight companies in the study are American- or European-/Scandinavian-based companies, whereas the inclusion of Asian pharmaceutical case companies might have provided a different picture. However, the present case study has no country and national cultural considerations and is indeed based on the assumption that pharmaceutical companies are major global players. Comparison of HRM practices in support of

radical pharmaceutical FEI across different national cultures might therefore be an interesting research theme to pursue.

In accordance with the call and the objective of this special issue, “Organizing for breakthrough innovation: Taking inspiration from the organization of science”, this article investigates which conditions, principles, and guidelines are applied in the organization of scientific projects with the purpose of increasing the likelihood of achieving breakthrough innovations. The organizing principle emphasized in the present study constitutes the adoption of human resource management practices relating to aspects such as recruitment, communication of ideas/innovation and collaboration/socialization among scientists, and provision of suitable incentives to advance scientific knowledge and radical FEI in the context of science-driven, knowledge-intensive pharmaceutical and biotech firms. The importance of innovation to KIFs like pharmaceutical and biotech companies cannot be overstated, and several authors emphasize that it might even be a defining factor of KIFs (e.g., Boxall and Purcell, 2003; Lei, Slocum, and Pitts, 1999; Swart and Kinnie, 2003). Many questions regarding the HRM–innovation relationship remain unanswered, however, especially in KIFs (Frenkel, Korczynski, Shire, and Tam, 1999; Newell, Scarbrough, and Swan, 2001). The innovation–HRM relationship in KIFs, such as pharma and biotech, has been largely unexplored despite calls for research in this area (Jackson, Chuang, Harden, and Jiang, 2006). This study therefore represents a theoretical and empirical contribution to this research area.

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Table 1. Overview of the pharmaceutical R&D process

Phase:	Chemical synthesis	Preclinical testing: pharmacology/toxicology	New drug filing	Clinical phase 1	Clinical phase 2 (100–500 volunteers)	Clinical phase 3 (1000–5000 volunteers)	New drug application	FDA approval
Duration:	Preclinical phase: 3.5 years			Clinical phase: 6.6 years				1.4 years

Source: Based on Sternitzke (2010, p. 812)

Table 2: FDA definitions of incremental and radical innovation

FDA DEFINITIONS		
Chemical composition	NME	An active ingredient that has never been launched in the US.
	Update	A medical component that includes a new formula, a new dosage of the existing ingredients, or a commercialized medical component utilized in a new way.
Therapeutic potential	Priority review drug	A medical component that represents a development regarding the accessibility of therapy.
	Standard review drug	A medical component with therapeutic qualities similar to other products on the market.

Source: Sorescu, Chandy, and Prabhu (2003, p. 88)

Model 1: A theoretical overview of the key bundles of HRM practices supportive of radical FEI

Table 3: Overview of companies and respondents in the study

	Company characteristics	Innovation focus areas	Respondents
A	HQ in Denmark operations in 58 countries >5,500 employees.	CNS (central nervous system), depression, schizophrenia, anxiety disorders, Parkinson's, Alzheimer's disease	27 research directors, 27 senior scientists and project managers, 26 lab technicians and research assistants
B	HQ in Belgium operations in >70 countries >10,000 employees	CNS, inflammation, oncology	1 research director*, 2 senior scientists
C	HQ in the US, operations in >100 countries 47,500 employees	Women's health care, neuroscience, musculoskeletal disorders, vaccines, infectious disease, hemophilia, oncology, OTC consumer drugs, animal health care	1 research director, 1 senior scientist
D	HQ in Denmark operations in 80 countries >26,300 employees	Diabetes care, hemostasis management, growth hormone therapy, hormone replacement therapy (HRT)	1 research director, 1 project manager, 1 senior scientist
E	HQ in Switzerland operations in >50 countries >12,000 employees	Neurology, respiratory, tissue management, osteoporosis, insomnia, cardiology, pain management, gastroenterology	1 research director, 1 project manager, 1 senior scientist
F	HQ in US operations in >35 countries >17,500 employees	Cancer care, anemia, rheumatoid arthritis, other autoimmune diseases	1 research director, 1 senior scientist
G	HQ in US operations in >54 countries >59,800 employees	Hypertension, cervical cancer, diabetes, asthma, allergic rhinitis, exercise-induced bronchoconstriction, cholesterol-absorption	1 research director, 1 project manager
H	HQ in Ireland operations in >10 countries >1700 employees	Sclerosis, Alzheimer's, Parkinson's disease	1 research director, 1 senior scientist

* “Research director,” “project manager,” and “senior scientist” are generic titles applied instead of e.g., “vice president” or “director of department X,” as the specific titles could potentially endanger the anonymity of the respondents.

Table 4: Categories of HRM practices supporting radical pharmaceutical FEI

Meaning category	Subcategories
1) Enabling innovation culture	1a) Minimizing the zero-error and risk-averse culture via storytelling, communication, and management 1b) Blame-free culture via storytelling and management 1c) Learning culture via tool training, measurement, and storytelling 1d) Focus more on exploration than exploitation in communications, goals, storytelling, and management
2) Supporting innovation management/ leadership	2a) Training managers in innovation management (tools, motivation) 2b) Managers as innovation role models 2c) Measuring innovation management
3) Communicating about innovation	3a) Communicating clear innovation objectives and innovation strategy 3b) Storytelling about exploration and innovation
4) Supporting innovative teams	4a) Cross-divisional collaboration and knowledge sharing (via communications, project objective, and cross-meetings) 4b) Ensuring diversity in teams (via project objective, innovation culture, and communication) 4c) Team-building across divisions
5) Supporting innovative individuals	5a) Identifying true talents/champions 5b) Supporting and motivating champions (via talent management, visualization, and communication)
6) Recruiting innovative talents	6a) Global recruitment of talents 6b) Diversity in recruitment 6c) Use of senior scientists’ networks for recruitment 6d) New channels to spot talents/champions (e.g., research, articles)
7) Facilitating training to build innovation capacity	7a) Generalist training modules 7b) Specialist training modules 7c) Individualized training
8) Managing talents	8a) Talent management academies 8b) Mentoring in talent management 8c) Individualized talent management programs

9) Measuring performance and applied types of appraisals	9a) Quantitative vs. qualitative performance measurement 9b) Monetary appraisals 9c) Non-monetary appraisals 9d) Individual vs. team performance measurement 9e) Appraisal packages
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Model 2: Summary of the study findings