The New Talent Management Challenges of Industry 4.0

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Abstract

Purpose:

The transformational changes to business environments brought about by the fourth industrial revolution create a perfect storm for strategic human resource management, prompting a need to explore the implications of this context for talent management theory and practice.

Design/methodology/approach:

In-depth interviews were conducted with HR Directors and Senior Leaders within engineering-led organisations to explore current challenges experienced across each stage of the talent pipeline: attraction and recruitment, training and development, career development, talent mobility, and succession planning.

Findings:

The speed of technological change brought about by Industry 4.0 had created a significant gap between current capability of employees and the rapidly evolving requirements of their roles, prompting a need to consider new and more effective approaches to talent development. Middle managers are increasingly recognised as overlooked critical talent within this context of unprecedented change, given their essential role in change management. In addition, whilst lateral hiring remains a common talent management practice, in the case of Industry 4.0 this equates to fighting a war for talent that does not exist.

Practical implications:

This study suggests that there is a need for evolution of talent management theory and practice towards a more dynamic, systems-thinking orientation, acknowledging the interrelated nature of different talent management activities.

Originality/value:

This paper provides an in-depth insight into the impact of the unprecedented change brought about by Industry 4.0 on contemporary talent management practice, considering how theory and practice might need to evolve to enable individuals and organisations to keep up with the rate of technological change.

Running Head: TALENT MANAGEMENT CHALLENGES OF INDUSTRY 4.0

Introduction

Alongside global demographic and economic trends, increasing global mobility, and expanding workforce diversity, the transformational changes to business environments and skills brought about by the fourth industrial revolution create a perfect storm for strategic human resource management (SHRM). As articulated by Beechler and Woodward (2009, 275), "*When all these factors are taken into combined account the result is a constantly changing, challenging and complex environment in which organisations must compete to attract and retain key talent*." Also referred to as Industry 4.0[1], the explosion of technological advances associated with the fourth industrial revolution include advanced robotics, augmented and virtual reality, the Internet of Things, ubiquitous connectivity and tracking, big data, and 3D printing, amongst a raft of other developments. The SHRM literature has long recognised that to leverage strategic human capital, organisations must effectively acquire or develop, then deploy employees to best apply their knowledge, skills, and abilities to tasks and processes in line with a firm's strategic needs and changing environmental conditions (Lepak and Snell 2002; Becker and Huselid 2006; Bassi and McMurrer 2007; Wang, Jaw and Tsai, 2012). However, the unprecedented pace and scale of change brought about by Industry 4.0 has led to a situation in which technology is increasingly outpacing individuals' and organisations' ability to adapt (Deloitte, 2017). The fourth revolution is considered to be fundamentally different to the previous three, as a result of being characterised by technologies that combine the physical, digital and biological worlds, and which will impact all disciplines, economies and industries (Schwab, 2017). Consequently, there is a pressing need to explore the extent to which existing talent management theory and practice holds within this context.

The critical skill shortages exacerbated by Industry 4.0 must be considered against an SHRM backdrop characterised by increasing reliance on lateral hiring as a means of rapidly plugging resource gaps (Gardner, 2002; Rao and Drazin, 2002; Amankwah-Amoah et al., 2017). Over the past decade, there has been a tendency for firms to respond to rapidly changing resource demands by 'poaching' readymade talent from competitors in order to address immediate talent needs (Amankwah-Amoah, 2018). However, this approach rests on the assumption that the required skills already exist within the system. The reality, however, is that many of the most popular roles in Industry 4.0 (including app developers, cloud computing specialists, data scientists, drone operators, and driverless car engineers, for example) were not even in existence 10 years ago (Baldassari and Roux, 2017). As a result, the skills required to undertake these roles do not yet exist within the education or talent system, or at least not in sufficient volume. In addition, as highlighted by Amankwah-Amoaha et al. (2017), the ability for external hires to significantly impact on a firm's performance is moderated by the existence (or absence) of internal factors such as supportive social networks. Appointing external hires into critical roles without any broader attempts to develop supportive internal networks is likely to lead to an under-utilisation of their talent (Groysberg and Abrahams, 2006; Amankwah-Amoah and Sarpong, 2014). Consequently, it is reasonable to assume that the extent of disruption triggered by Industry 4.0 requires a broader and more holistic talent management solution than simply plugging talent gaps through more intensive lateral hiring.

As highlighted by Collings and Mellahi (2009), the identification of critical talent is an essential component in any strategic talent management system, and attention within the talent management literature has shifted from a focus on identifying 'A performers' to one on the '*identification of key positions which have the potential to differentially impact on sustainable competitive advantage'* (p.307). Others have argued that it is technical expertise which provides the

[1] The term "Industrie 4.0" originates from a project in the German government's strategy, revived in 2011 at the Hannover Fair, and adopted in October 2012 by an Industry 4.0 Working Group reporting to the German federal government.

key competitive advantage in the global knowledge economy (Kim et al., 2014), a situation which could be argued as having been accentuated further by Industry 4.0. However, Collings and Mellahi (2009) further argued that it should be the strategically pivotal roles which also allow for potential differentiation between performances in the role that are most valued within an organisation's strategic talent management system. However, how this translates into practice, and the types of positions that are considered strategically important within the context of Industry 4.0, is unclear.

Furthermore, little research exists on the systematic management of technical professionals and experts across the employment life cycle (Kim et al., 2014). The most widely known approach to managing technical talent is the dual ladder system (Allen and Katz, 1986; Hesketh et al., 1992), yet it is claimed that the gap between the concept of the dual ladder and its reality is vast (Kim et al., 2014). Promotion for those in the technical track tends to become a "loyalty" prize instead of true career advancement (Allen and Katz, 1986). Equally, the relatively high search and replacement costs for managers in technical or specialist fields makes lateral hiring particularly challenging, enhancing the imperative for companies to create internal labour markets through development, in order to enhance retention (Wailerdsak and Suehiro, 2004). Indeed, practitioner survey data reveals that talent practitioners now anticipate a greater reliance on developing talent from within, as part of their future talent management strategies (CIPD, 2017).

Research on talent management has long been criticised for lagging behind practice in offering vision and leadership (Collings et al., 2011; Al Ariss et al., 2014; Cappelli and Keller, 2014). Whilst Industry 4.0 is likely to have triggered considerably different implications for talent management, developments in talent management theory have been largely incremental. For instance, although the net shortage of skills within the talent system could be interpreted as a need for greater diversification in talent management strategies (with more attention on internal development rather than external recruitment), substantial focus remains on essentially 'fighting harder' in the war for talent. In the case of Industry 4.0, arguably this means committing more attention and resources to fighting a war for talent that does not actually exist. Employer branding is an example of this, synthesising marketing principles and recruitment practices to develop a '*long-term strategy to manage awareness and perception of employees, potential employees and related stakeholders*' (Backhaus and Tikoo, 2004, 501), with the ultimate aim of strengthening talent attraction.

In an environment of rapid technological and organisational change, there is increased onus on organisations to look ahead in order to forecast future skills needs. Employer branding supplements this by creating a forward-looking employer brand, to attract employees with the skills and qualities that will be required to deliver against the long-term strategy. However, the risk is that a forward-looking employer brand, which reflects the type of work or working environment that an organisation aspires to create or deliver rather than the one it currently epitomises, creates a gap between internal and external organisational identities. This potentially triggers problems elsewhere within the talent management system – namely, in terms of retention and engagement of existing talent. Thus, to avoid turning a talent attraction issue into a talent retention issue, organisations must actively manage these multiple identities (Gioia et al. 2000), through conscious efforts to portray different identities to different stakeholders (Cole and Salimath, 2013). Again, this emphasises the importance of an holistic and systemic approach, to recognise and actively manage the mutually interacting influences of different components within strategic talent management systems. For instance, the impact of a talent attraction strategy aimed at promoting an employer brand that is aligned to longer-term strategic objectives must also be considered in terms its effect on the retention and engagement of existing talent.

Industry 4.0 creates a perfect storm for talent management, prompting a need to explore the extent to which existing theory is sufficiently representative of talent management within this new context. Tyszko and Sheets (2015), for example, emphasised that employers can no longer afford to wait for others to find a solution talent shortages, but instead must take a lead in exploring new approaches to closing the skills gap. In addition, Cappelli and Keller (2014) proposed that future research explores how employers think about talent management in practice, as a priority. Consequently, this exploratory study responds to both of these needs, by investigating the effect of Industry 4.0 on contemporary talent management practices. Specifically, it aims to explore the impact of Industry 4.0 within the engineering industry, where its effects are likely to be particularly heightened, since the technological innovations of 4.0 offer to revolutionise almost all points in industry's value chain (Schwab, 2015). In addition, engineering is an industry already beset with severe talent deficiencies, further exacerbated by declining numbers of entrants - particularly from minority groups - into the profession, despite the industry itself experiencing significant growth. Consequently, it provides an ideal environment within which to explore the impact of Industry 4.0 on talent management practices, and one in which clear guidance on the most effective approaches to strategic talent management is essential to help firms to succeed under these challenging conditions.

Methodology

Given the lack of existing research or theory addressing the talent management challenges of Industry 4.0, an inductive approach was adopted, involving a series of in-depth interviews with a range of senior figures in some of the UK's leading engineering-led organisations, many of them large, global organisations.

Participants

In-depth interviews were conducted with 12 senior leaders/HR professionals within engineering-led organisations across the Construction & Engineering, Defence, Aerospace, and Energy & Utilities sectors. Table 1 details interviewees' roles, the type of organisation they belonged to, and the size of the organisation in terms of number of employees.

[INSERT TABLE 1 HERE]

Procedure

A semi-structured interview schedule was designed to explore the current challenges experienced in relation to talent development and management, structured to identify challenges across each stage of the talent pipeline: attraction and recruitment, induction and onboarding, training and capability development, career development and talent mobility, employee retention, and succession planning. The interview schedule was developed by the authors, reviewed by the subject matter expert, piloted with a small number of practitioners not participating in the study, and adjustments made based on their feedback regarding question clarity prior to administration. Interviews lasted between 45-75 minutes, and were audio recorded.

Analysis

Recordings were fully transcribed, and the data were then analysed following Miles and Huberman's (1994) framework for qualitative data analysis data reduction; data display; and drawing and verifying conclusions. First-level coding entailed identifying meaning units, which were assigned

codes. The second stage of analysis involved identification of relationships between themes, both vertical and hierarchical. Conclusions were independently sense-checked and verified by the co-authors.

Findings

An overarching theme to emerge from the interviews was that the speed of technological change brought about by Industry 4.0 had created a significant gap between current capability of employees and the rapidly evolving requirements of their roles. As a result, the senior HR professionals interviewed emphasised a need for new and more effective approaches to talent development. As stated by this HR Director:

"*That balance of developing our own skills as well as bringing skills in, finding better ways to do that over the next 5 years will be key.*"

The nature of this challenge, and the potential shift required to respond to it, is outlined below in relation to each of the high-level themes which emerged from the analysis.

The talent attraction challenge

Several interviewees highlighted that due to ongoing skills shortages in the sector, firms must put significant effort into promoting their employer brand to attract potential employees. In the words of one Head of Capability Development, firms must now '*play the marketing game'*. However, the findings revealed that whilst a strong employer brand is considered valuable in attracting new recruits, a strong brand is typically build on experience, legacy, and tradition. The changing nature of engineering means that the public perception of the 'big brands', and indeed of engineering in general, has become outdated. In contrast, its image and the way that engineers are educated have largely remained unchanged. This growing misalignment means that not only is there an insufficient supply of engineering talent, but the industry is not attracting the desired range of talent. In the words of these interviewees:

"*The brand is still popular, but it doesn't attract a diverse population. If you want to just keep attracting more of the same, basically white males…We used to rely on our brand – we can't do that anymore*."

"*Attracting people isn't difficult but attracting people with the right mindset, and getting that spread of expertise and personality is becoming more challenging*."

Engineering remains associated with images of hard hats and heavy machinery, but the reality is that many engineers these days spend more time with design software and virtual reality modelling. Since this may appeal to a broader and more diverse range of young talent, the industry requires a rebrand to capitalise on the opportunity, as recognised by several interviewees. For instance:

"Maybe one of the things is redefining what engineering is, to some extent…I think there may be a bit of rebranding required about what being an engineer means. The bulk of our engineers sit in front of a computer screen most of the time, with 3d models. The product, most of the time, is virtual reality. Virtual reality models. That attraction strategy needs to change."

"People need to understand the range of engineering careers you can have. I think there's a real opportunity to educate within the school system, with parents, the careers system…"

New core competencies

A strong theme across all interviews was that, in addition to the engineering skills shortage showing no signs of abating, many firms are finding that new recruits are also ill-equipped to face the reality of modern engineering. The findings suggest that to be an effective engineer today requires a new mindset and skillset; a broader set of competencies that go beyond technical know-how. Interviewees revealed that rapid advances in technology mean that increasingly, engineers face challenges that involve large scale, complex systems, requiring cross-disciplinary interaction. Interviewees suggested that the complexity of modern engineering projects and client demands requires a whole new set of competencies, including commerciality, client management skills, relationship and communication skills, collaboration, systems thinking, and a stronger external market focus, as articulated by these interviewees:

"*It's not enough to be just a good engineer, we need you to be able to communicate with people, to come up with solutions, to be proactive, to work in a collaborative environment, out of box thinking*..."

"*We need less specialist engineers and more multi-skilled engineers…if we're going to keep pace with the way the industry is changing, and the requirement to respond to customer needs faster than we ever have before… we need more people that understand the whole [product] and the system integration in less depth - and pull on the expertise when it is needed - but can do that broader problem solving*."

A second-order theme in relation to the new required competencies, related to enhanced client expectations; clients now expect more than just a good engineering solution. One interviewee noted that he had "…*seen a change, a realisation that* [organisation] *needed to change its game to meet the expectations of its clients*."

With regard to leadership capability, interviewees recognised that in the past, those with the most technical experience have risen into the management and leadership roles in engineering-led organisations. However, as identified by one interviewee, now "*people coming into the business expect more from the people that lead them*." A number of interviewees recognised that this presents a challenge for large proportions of their management population:

"Leadership capability includes elements such as systemic thinking and leading with emotions. But we have about 40 thousand people who are used to the old way of thinking, the old guard…The concept is quite new to some, to accept that you may not always be the specialist, the technical expert."

The significance of these new competencies for the future of engineering was strongly inferred by this Head of Learning & Development for a large engineering and construction consultancy firm:

"*For us to be successful as a business, behavioural and technical competence are equally important. You might say we're an engineering business that's quite good at the people stuff, but we want to be a people business that's good at engineering*."

Finally, as a consequence of the shifting core competencies required to be effective in this environment, the interviewees identified a distinct lack of work readiness amongst newly graduated employees, adding further strain to an already stretched system. Two interviewees specifically cited a two year lag of suboptimal performance whilst new graduates get up to speed:

"Engineers that come out of university, are they useful to us immediately? No, they're not. How long does it take to become useful to us – maybe a year, two years…we need to think quite carefully about how we upskill our graduates. If universities aren't going to do it then we'll have to do it ourselves."

"There's a 2 year period between a grad coming in before they become fully productive."

Pivotal talent positions: The neglected middle

Several interviewees recognised growing divisions between the more experienced, middle-manager population and the 'HiPos' or 'emerging leaders' on whom the majority of talent development investment has typically focused. The middle management population was viewed as a neglected opportunity in terms of their own development and potential contribution. As explained by this Head of Learning & Development, and HR Director:

"*One of my challenges in [that] at some point you get a level of professional engineers and engineering managers who are of the past, and you get this new generation that potentially are going to leap frog above them. So how do you make sure your talent there gets the opportunity to rethink and re-train? I wonder if we will get a layer that will miss out. You've got to engage with that 'old guard'*."

"*It comes down to the new guard, old guard…There is something about educating some of the older population. There's a mindset chasm between the two*."

Indeed, the research identified signs of changing perceptions regarding older workers and their place within the talent development system, with one HR Director stating that: *"Persuading the organisation that you've got a 45 year old high potential… it's getting easier."* It also emerged that, if not integrated into the talent management and development process, there a risk that the middle manager population becomes a potential barrier to development of their line reports. Cross-functional mobility was an unfamiliar concept to the managers and leaders who are responsible for making it happen. As identified by these interviewees:

"*Retention and career development is problematic. Very senior people in our business will typically have been here for 30 years or more, with a mindset around development influenced only by their own experience. Typically, that was about climbing a specialist engineering ladder, technical capability being of prime concern, and slow and steady career development. The expectations of people coming into the industry are very different now and we have this cultural gap where senior people do not understand the challenge or have the skills to manage and develop young talent*."

"There is something about educating some of the older population… break through that myopic mindset and cut across all that protectionism that exists. Instead, recognising that for the good of that individual, for the good of the organisation, we're going to facilitate a move from there to there, and it's going to happen in the next 6 months."

Transforming talent management

Interviewees reported that typically, managers prioritise current performance over longer-term talent development: "*The day to day 'we need to get it over the line' tends to trump the longer term view*." Satisfactory delivery of projects in the immediate-term was prioritised above attempts to develop employees' capability for the longer-term benefit. Interviewees highlighted this as a key

limitation affecting the health of prospective talent pipelines; one that both exacerbates and is exacerbated by the talent shortage, making it a difficult cycle to break:

"Getting people to think beyond the next deadline, beyond the next quarter, to think more strategically, and risk assure the business in that length of time…we can be particularly short sighted, focused on the next quarter to the detriment of other things."

"*The mindset is about short-term tactical resource rather than long-term strategic resource. And clients want a safe pair of hands....it's such an uphill battle to change all of those mindsets*."

Furthermore, several interviewees highlighted a need for significant transformation in their firm's approach to talent management if they are to succeed over the longer term, but questioned how appetite for this could be generated in the absence of an immediate burning platform:

"Project losses have worsened over the last year, yet there's complacency; we're still successful; I'm still getting by dividends, my bonuses, why would I worry about it?"

"It's a vicious circle – managers not wanting to take risks. What will break that cycle? It needs to be disruptive enough."

To initiate the needed change, a number of interviewees suggested that HR must adopt a more challenging role, for instance, in encouraging managers to take appropriate risks on people for the benefit of their long-term development, and ultimately build a stronger talent pipeline:

"We should be accelerating people and taking the chance where we can a bit more…It's providing that challenge. Someone's got to do that, and I think it's down to the HR guys sometimes."

"And coming back to the HR people, are they pushing managers? Are they saying, why aren't we? …we need to be there showing the right way and providing the challenge."

"There needs to be that challenge, and if I can get our executive thinking like that, I think we have a chance."

Recognition was also made of the need for more of an integrated approach to development, which recognises and addresses the influences of factors such as organisational design, managerial attitudes, and organisational culture, on talent development. This interviewee described the limited impact that a disconnected training programme had had within their organisation:

"It's why the [name of business school] programme didn't work, it's why the [name of business school] programme didn't work …How much money have they spent on it? Millions. It's because of that environment. You can take people away, you can educate them, but of course they come back to an environment that is just not on the same wavelength."

Discussion

These findings suggest that to enable organisations to perform competitively in this changing landscape, the technological shifts brought about by Industry 4.0 require equally significant changes in talent management practices. Current approaches appear to be falling short in terms of equipping organisations with the talent they need to operate effectively within this rapidly changing environment. A combination of inadequate supply and insufficient internal development has resulted in many engineering-led firms operating with critical holes or 'pinch points' in their talent pipelines, whilst also losing talent due to an inability to fulfil expectations of accelerated career

development. As a consequence, talent pipelines have become thin, with insufficient volumes of talent coming into, or moving through, the pipelines to keep them healthy. Industry 4.0 has changed the nature of work significantly, calling for different skill-sets, with which formal education systems - in the case of engineering at least - do not appear to have kept pace. Formal engineering education remains segregated into technical specialisms, with an almost exclusive focus on technical knowledge and skills. This overlooks the increasingly networked, interdisciplinary and collaborative nature of modern engineering. As a result, the industry finds itself significant skills shortages and capability gaps, which threatens to limit industry growth. Castagnino et al. (2016) caution that:

"*…the Engineering and Construction sector has been slow to adopt new technologies, and has certainly never undergone a major transformation. As a result, productivity has stagnated over the last 40 years, or in some cases, even declined. This unimpressive record looks set to change very soon, and very dramatically*."

There are also key implications for strategic talent management theory, particularly around the identification of pivotal talent positions. Reinforcing the importance of shifting focus from identifying 'A performers' to identifying 'A roles' (Collings and Mellahi, 2009), the findings also highlight the need to challenge assumptions about the types of positions likely to be strategically critical within a particular context. Whilst it might be assumed that the pivotal talent positions within a context of unprecedented technological transformation will be technical positions, it is the middle management function that emerges as critical within the current study. Middle managers have been identified as increasingly critical to competitive advantage in the global knowledge economy (Kim et al., 2014), but their centrality within the cyber-physical revolution relates to their essential role in effective change management. Making the vital connection between strategic thinking and planning and implementation, middle managers are key determinants of effective organisational change, employee engagement and development (Davenport and Harding, 2012). Furthermore, the potential for differentiation in performance (Collings and Mellahi, 2009) amongst middle managers in this regard is vast. As key change agents and enablers of talent development, line managers must be fully engaged in the talent development process and understand the talent development needs across their entire business. Managers require development as talent managers themselves, educating in the benefits of talent management, development, and succession planning. Finally, they need to be rewarded for active and constructive participation in talent reviews and development planning, to discourage talent hoarding or obstructing career moves that would benefit the broader organisation and the individual.

In addition, whilst lateral hiring remains common in contemporary talent management, the findings of the current study identify a number of disadvantages in this context, adding to those already identified by Amankwah-Amoah (2015). Increasing importance is attributed to strong employer branding in order to compete for lateral hires, yet the legacy of a strong employer brand also brings challenges in a rapidly changing environment. The findings emphasised the importance of ensuring that the employer brand is forward-looking – reflecting what the organisation aspires to become rather than what it has been known for in the past, to avoid attracting in their shadow. However, the findings revealed the dilemma this can create for firms, in terms of balancing the need to present an aspirational image to future recruits, whilst not disengaging existing employees who are unlikely to identify with this image. Thus, to attract a different type of employee to those that have been attracted to their firm in the past, firms need to engage in active management of organisational identities (Cole and Salimath, 2013; Gioia et al., 2000) in order to avoid disengaging the majority of the existing workforce which still identifies with the legacy organisational image.

Finally, this study highlights the need for evolution of talent management theory and practice towards a more dynamic, systems-thinking orientation (Senge, 1990), to consider both the interrelated nature of different talent management activities and management of multiple talent populations across the employment life-cycle. A move away from talent poaching towards the concept of "shared value" (Porter and Kramer, 2011) appears critical, to build partnerships that extend the talent pipeline into communities while addressing larger training and education and employment gaps such as those within engineering and manufacturing. Consistent with Tyszko and Sheets' (2015) insistence that employers must take a lead in identifying new approaches to close critical skills gaps, Makarius and Srinivasan (2017) proposed a model of talent supply chain management (TSCM). TSCM takes concepts from the field of supply chain management and applies them to managing the development and flow of talent within organisations. By identifying the core capabilities needed to achieve the business strategy, and comparing this against current capability, a TSCM approach allows organisations to make informed "make and buy" decisions. This would enable organisations to determine what can be "made" in-house through development and what must be "bought" from potential partners through recruitment. Given the difficulty of making accurate predictions in a rapidly changing environment, a combination of make and buy approaches is likely to be inevitable, with internal development more amenable to meeting predicable needs, and external hiring for meeting unpredicted demands (Cappelli, 2008).

The findings of the current study reinforce the case made by Makarius and Srinivasan that the level of risk, uncertainty, and variability in today's labour market requires a different approach to talent development and management, and provides support for the potential value of the TSCM model. This has implications for the full range of talent management activities, from the supply of skills, to talent attraction, capability development, management development, talent mobility and career progression, and succession planning. In terms of the up-steam supply chain, for instance, the demand for new engineering competencies identified by the current study, on top of an existing technical skills shortage, underlines the need for stronger influencing and collaboration between engineering employers, end customers, and those who feed the talent supply chain. Within a supply chain approach, the efficiency of capability development is enhanced by targeting development activities based on an accurate assessment of talent development needs. Currently, however, it is reported that only 9 percent of companies believe they have a good understanding of which talent dimensions drive performance in their organisations (Deloitte, 2017). As a result, development becomes less efficient and the chance of return on investment diminishes. Mid-sized manufacturers alone are estimated to lose more than 11% in annual earnings or $4.6 million annually because of the skills gap (Accenture, 2014). Furthermore, Haskel et al. (2005) reported the skills gap (both hard and soft skills) to account for about 3-10% of the productivity gap between the most and least productive manufacturing firms. Instead, development needs to be aligned more closely to the competencies required to achieve longer-term strategic objectives.

Conclusion

The unprecedented pace and scale of change brought about by Industry 4.0 presents both a challenge and an opportunity for SHRM. As recognised by the CGMA:

"*Two of the most critical factors that determine an organisation's fate in this environment are the quality of its human capital and the way it manages its talent pipeline*." (CGMA, 2012, p.1)

This is the first known study to explore the impact of Industry 4.0 on contemporary talent management practices, and it makes several contributions towards furthering knowledge in this area. Most fundamentally, it highlights the value of taking a more dynamic and systemic approach, recognising the interrelated and interdependent nature of different talent management practices. Whilst acknowledging that differentiated and targeted talent management is necessary in order to maximise organisational resources, it needs to be recognised that the impact of targeted talent management interventions may be mitigated by forces in the broader talent system. For instance, as recognised by Amankwah-Amoaha et al. (2017), the ability for 'star' external hires to impact on organisational performance is likely to be moderated by the existence of supportive internal networks. Equally, a strong focus on talent attraction and recruitment as a means of meeting resource needs may be counterbalanced by increased employee turnover if this equates to a de-emphasis on development of existing employees.

In addition, despite the significant strategic value and potential for performance differentiation of middle management in this context given the critical role they play in effective change management and development of others, they have been largely overlooked as a talent population. This reinforces the need to challenge biases and heuristics which may be guiding identification of talent. Indeed, this is consistent with previous authors who have argued that in reality, "*Instincts and informed preferences and biases of key stakeholders often unduly bias talent decisions*" (Vaiman et al., 2012, p.927). Not only has the current pace of change brought about by Industry 4.0 led to a situation in which technology is outpacing individuals' and organisations' ability to adapt, but it is anticipated that this situation is only likely to get worse (Deloitte, 2017). Thus, to achieve any marked strengthening of talent pipelines, it may be more revolution than evolution in talent management practices that is required.

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Table 1. Participating organisations and interviewee role

Type of Organisation	Number of employees	Interviewee's Role
Specialist engineering firm	10,000-15,000	Head of Capability Development
Engineering component manufacturer & servicer	5,000-10,000	CEO
Engineering consultancy firm	15-20,000	Regional Head of Learning & Development
Aerospace	20,000+	HR Director Civil Aerospace
Defence	1000-5000	HR Director
Defence	1000-5000	Lead HR Business Partner
Manufacturing	10,000-15,000	Talent Management & Organisational Designs Director
Energy	20,000+	Lead Learning and Development
Utilities	5,000-10,000	Head of Talent
Construction & Engineering	1000-5000	Resourcing Business Partner
Construction & Engineering	1000-5000	Resourcing Business Partner
Engineering & Services	1000-5000	Head of Group L&D