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Navigating the gender structure in information technology: How does this affect the experiences and behaviours of women?

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Abstract

How do women, outnumbered and outranked, navigate work and careers in information technology (IT)? Only one in six information technology (IT) specialists in the UK is female. Such extreme male dominance potentially gives rise to a gender structure that affects women's experiences of IT work. Using data from interviews with 57 technically skilled female IT professionals, we examine how women orient this gender structure and how they make sense of their gender identities as women working in IT. Our findings elucidate how the IT gender structure shapes women's careers in this field of work. They reveal how women use their agency to assert notions of femininity into technical careers, disentangle narratives around whether women have unique and different (but less technically focused) strengths in IT and interface with 'geek' and 'nerd' identities to achieve successful IT careers. In doing so, they provide insight into how technical women continue careers within a structure that externalises them through gender norms. This understanding can be used to aid efforts to retain women within IT as well as other fields facing similar challenges.

Keywords

Female IT Professionals; Information Technology; IT; Gender; Gender Diversity; Gender Structure; Gender Norms; Gender Inequality; Structure and Agency

Introduction

Despite initial optimism that information technology (IT) would offer a new gender-neutral form of work (Walby et al., 2007; Woodfield, 2000); it now instead poses a pressing

challenge for gender-equality ambitions (Hicks, 2017; Misa, 2010; Tugend, 2017). Over 75% of IT workers in the United States are male, while the average for the EU15¹ is 84% (Tech Partnership, 2016). In the UK, the national setting examined in this paper, only one in six IT workers is female. Such a stark gender imbalance makes it one of the most male-skewed, white-collar occupations in the country and one that faces a growing shortfall of much-needed IT professionals (Tech Nation, 2017; Tech Partnership, 2016).

Interest in women's underrepresentation in IT spans an array of disciplines and streams of literature, including careers, gender and technology, information systems, organisation studies and HRM. Existing research into how women experience working in IT has primarily adopted a social constructionist lens (e.g., Belgorodskiy et al., 2012; Cox, 2009; Crump et al., 2007; Frenkel, 2008; Guerrier, 2009; Howcroft and Trauth, 2005; Kelan, 2007a, 2007b, 2008, 2010; Wajcman, 2010). This has helped explain how women experience their working lives in this field by providing insight into localised interactions between women and men in IT and how gendered roles are constructed and performed (Trauth, 2013), including individual choices, traits and attributes (Ahuja, et al., 2006; Trauth, 2002), which are viewed as being socially programmed and practiced (Nentwich and Kelan, 2014; Raz and Tzruya, 2018).

While we deeply acknowledge the social construction of gender, we argue that in the case of IT, the sex disparity is so pronounced that it is imperative for us to examine the binary categories of male and female and to consider their broader effects on the identities of female IT professionals. Drawing on theoretical interpretations of gender as a social structure (Acker, 1990, 2006; Mader, 2016; Martin, 2004; McCarthy and Moon, 2018; Risman, 2004,

¹ The EU15 consists of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

Risman et al, 2018), we argue that the numerical dominance of a field by one sex may lead to cultural and systemic hegemony, generating a prevailing narrative, or a 'glass slipper' effect (gender-embodied occupational social identities leading to conscious and unconscious biases with favourable and unfavourable outcomes), thus influencing the nature of work and individuals' experiences and behaviours (Ashcraft, 2013).

The application of this type of lens is pertinent in the case of IT, because women in IT may expect or demand greater openness compared to those in occupations where male predominance is more longstanding. Indeed, being highly skilled and educated, they may be conscious of inequalities and use their voice and identity to question existing norms and crack the glass slipper they are presented with (Deutsch, 2007; Kalev, 2018; McCarthy and Moon, 2018; Women in High Performance Computing, 2017; Women in Tech, 2017; Wynn and Correll, 2018).

Thus, we seek to shed new light on the behaviours of female IT professionals by investigating two principal research questions. First, how and why does male dominance of the IT employment structure influence women's gender identity? And, second, how do women navigate this environment and use their agency to challenge the features of this structure and uphold their fit in IT?

In addressing these questions, we structure this paper as follows. We first discuss the gendering of IT expertise and examine recent research on women's IT experiences.

Subsequently, we thoroughly review the existing perspectives on gender in IT, focusing on the work of scholars who argue that gender acts as a social structure that shapes the working environment and actions of women in male-dominated settings such as IT. We then present

our findings, revealing how women working in IT navigate this gendered social structure and how it affects aspects of their gendered identities as female IT professionals. The findings enable significant contributions to the refinement of structural gender perspectives by casting light on women's efforts to disrupt gendered structures and identities in IT work.

UK women working in IT

The UK provides an interesting and distinctive setting for the analysis of women's experiences of IT work. The sector is vaunted as a national 'success story' because of its above-average growth and international market share, making the UK the IT capital of Europe (InvestinGB&NI, 2018; McGoogan, 2017; Tech Nation, 2017). Such international success would seem to be reflected in the UK's position as seventh in an index of 41 OECD and EU countries on pay and opportunities for IT women (Honeypot, 2018). However, this contrasts with national-level assessments on gender equality (Tech Partnership, 2016; Tech Nation, 2017). In the UK, women hold only 16.2% of IT jobs and the UK has the largest gender pay gap of the top seven countries, drawing into question the UK's performance in terms of gender parity in IT work (Honeypot, 2018).

By holding technical IT roles in this type of environment, women are likely to work in settings where their competence and belonging are questioned. How this affects women has been the subject of a large body of scholarly work (Griffiths and Moore, 2010; Hari, 2017), but existing research has mainly explored the reasons for women's absence from IT (Griffith and Moore, 2010; Kelan, 2007a) rather than the way women experience their IT careers and the role played by gendered identities in the process.

Women's low uptake of IT careers and their higher turnover rates suggest that many of them either anticipate or experience a less-than-positive experience of working within the industry. A study of women who left the UK IT industry found that sexism was one of the principal reasons for their departure (Griffiths and Moore, 2010). More recently, practitioner literature and press reports affirm that the climate for many women in IT continues to be hostile and unwelcoming (Brockwell, 2017; Devlin and Hern, 2017).

Studies that have examined women who have stayed in IT and who have navigated certain assumptions about their technical abilities and competence have focused on two key elements: (i) how women reconcile their gender identity with their career choice and (ii) their tendency to move away from more technical roles.

Looking into women's perspective of the relationship between their gender identity and their IT skills, Adams et al. (2006) found that women distanced themselves either from their IT work or from their identities as women. They argued that, to some extent, such women become a de-gendered 'it' rather than male or female. However, since the research was undertaken over a decade ago, women's behaviours may have changed as the industry has matured.

Studies that have explored female attraction to or migration to less technical IT roles have largely focused on how such roles facilitated career progression to a point in organisational hierarchies, as few women succeed to board-level positions (Crump et al., 2007; Roan and Whitehouse, 2007). Managerial and team-leader roles offer some degree of advancement for female IT professionals. Narratives about females possessing greater strengths with respect to interpersonal communication and task coordination skills make female movement into

these roles seem a logical and almost inevitable career path (Guerrier et al., 2009). For example, 27% of IT programme and project managers in the UK are female (Tech Partnership, 2016). A danger here is that if women are steered towards these hybrid roles, as they may be perceived by men as invading their 'space' (Hewlett, 2007; Puwar, 2004), it will reduce the number of women in technical roles and reinforce the contention that women are not technical (Fernando et al., 2018; Srinivas, 2011). In addition, evidence has been found that women may have some success in accessing more junior and mid-level management positions but are still disadvantaged in attaining more senior technological roles (Adams and Weiss, 2011; Bevan and Gatrell, 2017). This necessitates an investigation of women's interpretations of and responses to this unfolding landscape for their careers.

Examining gender as a social structure

Andersen (2015) sets out three key positions on gender: (i) it is seen as an institution or regime pattern (e.g., Acker, 1990, 2006a, 2006b; Connell, 1987; Martin, 2004), (ii) it is performed (e.g., West and Zimmerman's 'doing gender'), and (iii) it acts as a social structure (e.g., Risman, 2004). Each perspective usefully highlights the dynamic nature of gender and its relationships with societal structures, human agency and culture (Andersen, 2015). For the analysis undertaken in this paper, we draw on gender structure theory, which synthesises relevant elements of the other two positions (Risman et al., 2018), because, as will be explained below, it provides the most holistic analytical framework for this study's focus on structure and agency in IT work.

With respect to gender as an institution or regime, Acker's (1990) influential theory posits that although an organisation may present itself as gender-neutral, assumptions about gender underpin all aspects of an organisation's function, including its structure, job design and

remuneration. Organisations typically operate hierarchically, wherein work activities and behaviours associated with men's bodies and masculinities are usually more highly valued than those connected with women (Acker, 1990). Such gender-inequality regimes operate at organisational, occupational and sectoral levels, affecting assumptions, interactions and outcomes for both male and female employees (Acker, 2006a, 2006b; Ashcraft, 2013; Duberley et al., 2017).

Building on this, Martin (2004) characterised gender as an institutional dynamic that influences ideologies, practices, interactions and outcomes. The institutional approach to gender is similar in many ways to the idea of gender as a social structure; Risman (2004) adopted an institutional approach in forming her theory of gender as a social structure. Both scholars perceive gender as endemic to social life: existing outside an individual, constraining and guiding action, being constituted and re-constituted by agents and being internalised and therefore influencing identities. However, in contrast to an institutional perspective, Risman classified gender as a social structure, rather than an institution to place gender on the same analytical level as political or economic structures (Risman 2004).

Risman et al. (2018) maintain that gender structures run deep and result in separate opportunities and constraints for men and women on three levels. These include: (i) the individual level, influencing the development of the gendered self; (ii) the social interactional level, through which men and women potentially encounter different cultural expectations even when ostensibly occupying the same structural roles; and (iii) the macro institutional level, where their sex may act as criteria for the allocation of resources and material goods. Risman et al. (2018) stressed the strength of cultural imperatives emanating from this gender structure and how they result in inequality. Men and women often construct members of the

opposite sex as ‘the other’ and hold perceptions about each other’s relative strengths and weaknesses. One might expect a male-dominated gender structure to collapse when men and women hold similar occupational roles. However, an existing relational structure is likely to persist (Oliver, 1992) unless it is consciously challenged (Kalev, 2018; McCarthy and Moon, 2018; Wynn and Correll, 2018) because people create and influence a gender structure (Ashcraft, 2013). Consequently, a greater understanding of the relationship between a gender structure and the agency of women is needed.

Using Giddens’ structuration theory, Risman et al. (2018) provided a framework for understanding this iterative relationship between an individual and relevant gender structures. Giddens contended that although social structures shape action, people also influence social structures. As a consequence, he argued for a duality of structure with the two shaping, reinforcing and sometimes changing each other, without individuals always being aware of the extent to which their agency is being moulded by a structure (Akram, 2012). Risman et al. (2018) used this to argue that gender as a social structure shapes identities and interactions and organises social institutions, occupations and organisations.

In connection with this, Mader (2016) discussed the social-structure notion of gender. He asserted that gender acts as a structural category that provides separate and unequally valued meanings of what it is to be male or female. These meanings may result in different opportunities and constraints on action for both men and women. Mader posited that these gendered structures and cultures can be used to explain the actions of agents and how and why men and women are steered into performing particular organisational tasks and roles.

Mader used Archer's (1995, 2007) work to explain the relationship between this gender structure and human agency. Archer's morphogenesis model views social structures as pre-existing conditions that provide opportunities and constraints, with the actions of human agents either reinforcing or altering these social structures. Unlike Giddens, Archer (1995, 2007) saw social structure and agency as interconnected but irreducible to each other. Individuals can think about and judge the social demands placed on them and '*an intra-subjective logic, which also includes the materiality of the body and emotionality*' (Mader, 2016: 442), influences how they act in light of structural imperatives. Thus, the social conceptualisation of gender, along with its social settings, creates a specific set of circumstances that surround the ways actors pursue their goals reflexively. In addition, Mader employed Archer's (1995) concept of 'social position' to show that men and women occupy different positions in relation to social resources and power. On this basis, social position structures action as it forms a material element of the situation the actor is in and shapes their reflexivity when deciding how to act.

Mader (2016) also drew on Waternberg's (1990) work on domination to explain how gender operates as a social structure. He used Waternberg's definition of domination and positioned it as a hegemonic social relationship where one group or individual has ongoing *power over* another group or individual. This definition also encompasses the idea that power is exercised to the detriment of the dominated (Bourdieu, 2001; Cockburn, 1991). Domination works not only through direct command and control but also by mobilising bias and subtly circumscribing the amount of social space available to the dominated to act (Connell and Messerschmidt, 2005). Dominators generally use their power to restrict the options for action available to the dominated and manipulate their interpretations of what is believed to be possible (Lukes, 2004).

Within a male-dominated field, gender potentially acts a social structure that influences gendered behaviours (Gatrell et al., 2015). The ways gender is defined may mean that women make decisions on their own careers within the context of how they perceive themselves relative to men and whether they see themselves as facing constraints over how they act. Their own conceptions of their position as female IT workers are also likely to be influenced by some of the more subtle and indirect aspects of the male-dominated nature of the field (Demaiter and Adams, 2008). Yet the actions of women and the way those actions are interpreted by both their male and female colleagues also contribute to the gender structure within the occupation (Ashcraft, 2013). This will be examined more deeply through this paper. In the next section, we investigate some of the contours of this gendered social structure and discuss their impact on the agency of female IT workers.

Gendering technical expertise in IT

The emergence of IT in the late 1950s (Hicks, 2017) offered the prospect of a new, less gendered occupation, decoupled from the need for high levels of physical strength (Huyer and Hafkin, 2007; Shire, 2007; Woodfield, 2000). Indeed, historical analyses have underscored the critical role of women in the development of computing in the UK and around the world (Brockwell, 2017; Eveleth, 2013; Isaacson, 2014). However, such analyses have also revealed how IT jobs and organisations have become more masculinised over time in contrast to other high-skill occupations including law, accountancy, science and medicine (Ensmenger, 2010a, 2010b; Hicks, 2017; Hirshfield and Glass, 2018).

Research has suggested that the increase in the proportion of male workers has fed into IT work cultures, norms and values (Wilson, 2003), influencing the identity of the occupation

and its members (Ashcraft, 2013). Indeed, IT work has been stereotyped as male (Ensmenger, 2010a, 2010b; Heilman and Eagly, 2008; Hicks, 2017; Smith, 2013; Varma, 2007) partly because technology has had a long association with ‘maleness’ and has been used as *machinery* to reinforce and extend male dominance of work and gender relations (Wajcman, 2010). Indeed, Cockburn and Omrod’s (1993) classic text illustrated the distinctive roles of men and women in the social production of the microwave oven and its part in disadvantaging women at both home and work. Unlike other occupations that are heavily male-dominated, IT design processes and cultures extend beyond the occupation and thus need to be contested (Calás et al., 2014), otherwise they will continue to primarily advance men’s interests (Ashcraft, 2013; Oudshoorn et al., 2004).

In the case of IT, studies have indicated that a variety of masculinities are evident (Duerden Comeau and Kemp, 2011; Ensmenger, 2010a, 2010b), but one specific type of masculinity that is most salient and highly valued in IT is that of the technical expert. Duerden Comeau and Kemp (2011: 60) argued that masculinity in IT is based on masculinities in engineering, the military and maths, with an emphasis on the *‘mastery of technical skills and the sublimation of the social’*. In a similar vein, many authors have pointed out that the occupational identities of both engineering and IT professionals are infused with hegemonic masculine concepts such as technological skill, independence and competitiveness (Demaiter and Adams, 2008; Fernando et al., 2018; Webster, 1996).

This masculine culture in IT is reinforced through a particular type of ‘geek/nerd’ culture (Isaacson, 2014; Varma, 2007). Webster (1996: 40) argued that as programming developed, it moved from a craft to a ‘hacker culture’, leaving behind some of the focus on systematic work-based training and instead acquiring skills and knowledge *‘on a voluntary and informal*

basis'. With some men professing a strong passion for IT and a willingness to devote substantial time to develop a deep mastery of programming, IT became associated with specific forms of masculinity that began to alienate women (Cringley, 1992, cited by Webster, 1996; Hari, 2017; Stocking, 2016). Contemporary manifestations of this culture value certain qualities typically associated with men (Cox, 2009), including an embodied physical look, technical prowess, geekiness and a fervent love of technology (Crump et al., 2007; Varma, 2007; Wajcman, 2004, 2009; Wilson, 2003).

Varma (2007) suggested that it is often more difficult for women to adopt these norms because it is harder for them to fully embody geek- or nerd-like identities. As a consequence, women may struggle to be seen as 'honorary men' even if they try (Höpfl and Matilal, 2007). This is because men typically interpret and reframe notions of masculinity to suit their interests. While being a nerd or geek would not have been seen as masculine or fashionable in the past, now that it is associated with technology and money, it has been reframed as a desirable space and image for men relative to other masculinities and women (Coles, 2008).

Indeed, IT programming has come to be seen as an esoteric 'black art' (Ensmenger, 2010a, 2010b) and something one is inherently good or bad at, with women concentrated in the latter category. Faced with the widely held view that technology is innately masculine, women working in IT have to defend and extend their space and visibility and at the same time face pressure to not overstep and affront male sensibilities (Babcock and Laschever, 2003). A recent example would be James Damore's 2017 anti-diversity memo titled 'Google's Ideological Echo Chamber', which drew on essentialist beliefs to question the place of women in technical IT work (Brockwell, 2017). The aim of the study presented in this paper

is to understand how women in IT navigate their gender identity in such a heavily male-dominated environment that ostensibly prefers 'male' technical expertise.

Methods

The target demographic for participants in this research was women working in technically skilled IT roles in organisations across the UK. This is because this demographic range, which was not restricted to participants from a particular organisation or group, provided a broader and richer insight into the gender structure in IT in the UK. Women working in IT are relatively scarce, and so participants were recruited through a range of channels. A webpage for the study was launched, inviting UK-based female IT professionals who were currently or had previously worked in technically skilled IT roles for at least 12 months to contact the first author to participate in a study on gender and female IT professionals. For the purposes of this study, 'technically skilled roles' was defined as involving the analysis, design, implementation, operation, maintenance or security of a system or product (software or hardware) for an internal or an external client. This definition of technically skilled IT work was checked with both male and female industry contacts. The webpage was hosted by the first author's university and then publicised through several channels the researchers had contacts with. These included organisations within the IT industry, professional services and consulting. Details of the webpage were also circulated via key networks for female IT professionals, such as the British Computing Society's Women's Group, Women in Security and Women in High Performance Computing.

Individuals who expressed an interest in the research were given an information sheet, and informed consent was obtained before data collection. Data were collected from 57 women working in technically skilled IT roles. To provide a broader insight into the industry, we

recruited women from a variety of organisations. Saunders and Townsend (2016) recommended recruiting around 50 participants from multiple organisations for qualitative interviews, and so 57 provided a good sample size.

The women were recruited from a range of companies, but the majority worked for IT companies, telecoms, oil and energy, financial services, publishing and media. Six of the participants were self-employed and worked as contractors, typically on long-term contracts. One participant had recently left her IT role and was undertaking further study, and another had just taken a career break. The sample included software developers, solutions architects, IT security specialists, project managers, IT consultants and business analysts. Participant sectors and their occupations are indicated in Table 1.

Each of the organisations the employees worked for had varying gender balances, and most of the women worked with or had worked at organisations with such a feature. In many cases, they were or had been the only woman in the teams or departments they were members of (see Table 1). Our sample largely consisted of experienced IT professionals, many of whom had progressed through the ranks to senior roles, and this enabled us to gather data from a cohort of professionals who could credibly reflect on how they experienced gender structures over time. The characteristics of the sample therefore provided the opportunity to gain a valuable and distinctive insight into women's experiences of working in IT in the round.

The respondents were 23 to 62 years old, with a mean age of 44. Forty-four of the participants were white British, and seven were from other white European backgrounds. Six were from minority ethnic backgrounds. Thirty-one of the 57 participants were mothers.

The first author, who is female, conducted all the in-depth semi-structured interviews. The interviews were conducted face-to-face, by telephone or by video depending on participant preference. In line with the aims of the research, the interview questions covered their career journey into and through IT, focusing on their experiences as women in various IT roles. Participants discussed female representation and the culture of their organisations as well as how they experienced those workplaces as women. The interview questions were designed to enable the respondents to express their views and experiences in their own words rather than assuming or implying the existence of the effects identified in the literature reviewed earlier (Rubin and Rubin, 2012).

The interviews varied in duration, with most lasting between one and two hours. All but two interviews were recorded, and detailed notes were taken in those cases. The interviews were fully transcribed and the data imported to NVivo, where an *a priori* coding framework was developed to aid the careful and systematic analysis of the data. This initial framework was formulated by reading through the data and identifying key themes and sub-themes. Notes on emerging themes collated by the first author during data collection supported this iterative process.

An open hierarchical coding framework was developed with 6 main themes and 68 codes that covered how the women entered the industry, how they experienced the industry and how they felt female representation could be improved. As this paper focused on how the women experienced the industry, we drew on the data coded under two of the main themes: 'Experiencing a career in IT' and 'Gendered experiences whilst working in IT'. Examples of second-order codes under these headings included 'Fit and belonging in IT', 'Fit and belonging in a team' and 'Gendered behaviour comparisons' (see Table 2). The themes in

this framework were used to code the data progressively with second- or third-order codes (Sinkovics and Alfoldi, 2012).

The first author primarily conducted the coding, but both researchers reviewed the coding to improve its reliability. To further enhance the rigour of the analysis (Rubin and Rubin, 2012), a third, independent researcher was asked to thoroughly review the coding of five interview transcripts (more than 200 pages of textual data) and use her experience of qualitative coding to help check for divergent data interpretations and to improve the inter-rater reliability of the coding. The coding was discussed with the independent researcher and minor adjustments were made where appropriate. Seven interviews were coded before the framework was fully developed. The comments by the second author and the independent researcher were used to refine the template before it was applied to the full data set, including the original seven. The quotes presented below exemplify the views and experiences expressed by the participants.

Findings

The findings shed light on how female IT professionals navigate gender structures in IT and their efforts to challenge the gendered structures and identities they were presented with and affirm their fit in the profession. In line with the focus of the two research questions, this section is divided into the same number of parts: the first reveals how the women experienced gender as a social structure in IT and the second then examines how they challenged three key facets of this structure and how they sought to uphold their fit and identity accordingly.

(1) Experiencing the IT gender structure

Analysis of the respondents' accounts of the occupational and organisational cultures in which they operated led to the identification of key recurring characteristics of these cultures. The cultures included male-centric and distinctive geek- or nerd-like features. The cultures they described were marked by male-held assumptions about women's inherent lack of technical ability. Although the women sampled were skilled and successful computing professionals, clients and male colleagues typically assumed that they lacked technical competence.

I think some men may not take you for quite so competent when they first meet you . . . they don't assume women are very technical in general . . . you have to show you that you are, whereas if you're a man and you say, 'I'm technical', you don't have to know anything. If you just say the words 'I'm technical', they're okay with that.

(Cara, Senior IT Analyst)

I have had to sell myself a lot more, potentially, and make it known that I do have a skill set, I do have a technical understanding . . . (Nell, IT Security

Management)

The participants indicated that male colleagues considered it rare for women to be technical. Discussing her interview for a senior technical position, one of the participants recounted how, as a technical female, she was compared to a mythical being

When I had my interview . . . one of them [male interviewers] stood up and said, 'that was lovely' . . . They apparently went back out to their colleagues . . . jumped up and down with excitement and said they'd found a unicorn. (Denice, Senior Software Engineer)

In place of strong technical skills, the participants explained that they were regarded as possessing strong communication, people management and organisational skills. These skills were perceived to make them better suited to so-called 'housekeeping roles'.

Women . . . are sort of split into two areas. They tend more to be in project management . . . or operations . . . Operations is basically like the wives of the office, they make sure that food happens . . . And then, on a project, the people that keep it ticking over [are] the wives of the project. (Abigail, IT Consultant)

The accounts of these participants revealed that they largely assimilated these views by behaving as expected. These were arguably ways they may not choose to conduct themselves at work, if less constrained by the male-dominated environments in which they operated. The degree to which male norms were embedded meant that they faced substantial pressure to accept imposed patterns of behaviour. This did not mean that they had to act like males. Instead, they had to learn how to act as females in a male environment by adhering to established and emerging scripts, which positioned them as outsiders or guests rather than individuals who naturally belonged in IT. To do this, they felt the need to maintain the status quo rather than vociferously pressing for change.

I'm not very good at sitting there quietly and minding my own business. I expect to be listened to, because I only speak when I have something worth saying. But the level of assertiveness I have to exhibit to get my point across at times, not just because of the interrupting . . . But also to get the weight of 'This is important, and I know it and I can back it up so let's engage in what I am saying'. It feels like I have to put more effort in . . . than a man who can just say, 'Well I've had an idea. We should talk about it'. (Gail, IT Business Analyst)

Male dominance meant that they were often excluded from activities or events that offered referent power and informal influence over decision-making. Surprisingly, much of this exclusion was hardly a concern to the women sampled, as they indicated little interest in permeating male-dominated social interactions and structures. However, this exclusion meant that they sometimes had to address the assumption that they were not IT professionals.

There is a very dim view of females in IT. I'm more often than not asked if I'm in marketing, sales or maybe HR. (Iona, IT Project Manager)

I do hate it when people make assumptions that I'm either a secretary . . . There's nothing wrong with secretaries, but I'm not one. We have some wonderful ones. Or that I'm in HR or something. When I say, "Actually, yes, I was a programmer once. I had a technical background," they go, "Really? I never realised. Oh, I'm sorry. I should speak in [computer] code, then? (Katrina, Senior IT Manager)

This was because their fit and expertise were often called into question both by the firms they worked in and by external parties, reflecting IT gendering in and outside IT workplaces.

(2) Women's agency in the gender structure

In this section, we examine how the gender structure influenced the gender identities of the women in three key respects and how they navigated their IT careers. First, we discuss how the gender structure generates a complex relationship between fit and femininity within IT. Second, we relate the gender structure to how the women frame scripts around 'female strengths' in relation to IT work. And, third, we use these findings to demonstrate how they navigate the 'geek culture' in IT as female professionals.

Femininity, fit and IT

All but six of the respondents felt that, unlike men, they could not take their place in IT for granted. This meant that they experienced greater pressure to always exhibit a high degree of technical competence and be better at their jobs than their male counterparts.

There's a tremendous pressure . . . you've got to be better than one of the boys, because they're looking for you to fail. (Justine, Senior IT Manager)

I've been out on . . . maternity leaves, and [now] I'm back . . . It is a challenge . . . IT and security move on regardless, and there are some sort of psychological things that I do because I'm a woman . . . things like, in my signature on my emails I do put . . . some of my certifications. . . I hate that I have to do it . . . ones that

would make them think, okay, she's at that level of knowledge. (Kelsey, IT Security Manager)

In addition, more than two-thirds discussed the normative or coercive pressure they faced to de-emphasise their sexuality and any gender differences along with displays of emotion. This is exemplified by the following quote:

At work, people would describe me as very driven, very tough . . . And I'm actually not like that. It's a mask, an act if you like, that has developed over the years, because I've had to, and because that works. (Justine, Senior IT Manager)

Dress code was another manifestation of this normative pressure to blend in with male colleagues and fit in as an honorary man (Höpfl and Matilal, 2007). The women were not always consciously aware of this as 'pressure' as such; for example, Chloe, an IT developer and team leader, described her workwear as *'black trousers and a top'*. She did not question what she wore until she moved into a role where she shared an office with more women and saw that they tended to wear much brighter colours. At that point, she allowed herself to vary her wardrobe a little. Imogen, however, explained how over time she picked up on the subtle pressure to dress in a less feminine manner:

You realise after a few years of only working with men that you just don't dress up . . . if I had been someone who turned up in a dress and makeup and everything to work, I probably wouldn't have fitted in quite as well.

When they did exhibit their femininity, a third of the participants referred to the pressure to stick to existing scripts and to only display or voice an approved type of femininity (Babcock and Laschever, 2003). Otherwise, this could generate frictions at work.

I am quite audacious and outspoken, so I'm sure that that rubs people up the wrong way sometimes, when they think 'she's not acting the way a girl should be'. (Abigail, IT Consultant)

The data also indicated that, to get by as outsiders, the women were expected to display certain types of behaviour, as there were predefined rules or norms for them to follow. However, some of them saw value and strength in their femininity and wanted to bring it with them to work in discreet ways. This was because it constituted a core element of their self-identity. One-third of the women referred to the importance of the sartorial elements of gender or specific interaction styles to visually signal their presence as women embodying femininity (Haynes, 2012).

I used to wear trousers all the time until one day I stopped. And thought, 'Hang on, what are you doing? Don't try to be one of the boys . . . There's nothing wrong with showing that you're female'. (Justine, Senior IT Manager)

Occasionally, I'll realise I'm the only woman in this room . . . perhaps because of that, I always wear nice dresses to work, things like that. I just think, 'Well, why shouldn't I assert my femininity in the place that I work?' (Wanda, IT Business Analyst)

As part of the minority, they sought to preserve their femininity by carving out a distinctive identity. This enabled them to differentiate themselves from their male peers.

I don't want to be like a man . . . let the boys do their thing. I bring a different flavour and I'm proud of that. (Brenda, Senior IT Manager)

The data highlighted a gender structure in the IT profession that separated the constructs of technical work and femininity (Bevan & Gatrell, 2017). About a third of the respondents challenged this by consciously seeking to present a more formal professional identity compared to their male colleagues. This was partly because this reinforced their professional credibility and challenged the notion that IT was inherently male. Indeed, some worked to subvert the notion that femaleness and technology were abject and could not coexist. As they saw it, femininity and IT do go together, and so they sought to disrupt established intra-gender appearance expectations in IT (Haynes, 2012; Höpfl and Matilal, 2007; Mavin and Grandy, 2016).

It only dawned on me the other day. I was saying to my mum, I can do technology, and I can look amazing, and looking amazing does not mean I'm dumb. Doing technology does not mean I have to look crappy. It's okay to pop the two together.
(Davina, IT Business Analyst)

The data provided examples where women considered themselves to be accepted and displayed aspects of their female gender more freely. One of the participants who worked in a senior technical role and who felt accepted by colleagues and clients started exhibiting her 'eccentric' look and personality more prominently because she no longer felt the need to

conform. Another spoke of increasing confidence on behalf of herself and her female colleagues in challenging male norms and expectations of women in the industry:

This is the first place . . . where I've not had to dumb myself down . . . the women that I'm working with aren't afraid to, they're not trying to be male. (Davina, IT Business Analyst)

While the male-dominated nature of the sector influenced how the women acted, the way they conceptualised and expressed their femininity at work was not completely subjugated to male norms. As indicated by the quotes above, some questioned and challenged the influence of these norms on their behaviour and identity. However, this is not to say that such norms did not continue to influence the women in other ways. Indeed, this is a complex phenomenon because the comments made by the women in the following section suggest that they recognised that women generally tended to occupy less technical roles. These roles often pulled them away from the forefront of technology and typically relied on supposedly softer 'female' skills (managing, organising, planning, communicating), which were perceived to be less evident among men.

Female 'strengths' in IT

Twenty-five of the participants indicated that they adapted to what would be characterised as essentialist conceptions of female IT professionals. They embraced stereotypical essentialist views (Heilman and Eagly, 2008) but only when this was beneficial in terms of their promotion to managerial roles.

You have got far more business analysts . . . which is a role that women seem to pick up really well . . . Because you have to draw requirements out of people – there is more empathy, there is more nurturing, more coaxing. Women are perhaps more easy and able to do that with other people than perhaps men are . . . Men are still business analysts but there is a higher proportion of women that are business analysts than there are, say, architects or programmers or project managers.

(Esme, Senior IT Consultant)

There were also more subtle norm-based pressures that made it appear natural and normal that women worked in roles that demanded the use of so-called softer skills (Bevan and Gatrell, 2017). As Oona stated,

[F]ewer women . . . seem to stay technical. A lot of women end up going managerial-type routes so it can be quite odd when you seem to be the only person still in that kind of role. (Oona, Software Developer)

A third of the participants indicated that women were sometimes strongly encouraged or pressured to take on such roles because male colleagues drew on stereotypical views about their inherent strengths.

[W]omen in technical roles get moved out of technical roles. It's partly a compliment that people think women have better communication skills . . . better people skills and . . . communication skills . . . but underneath that is also an idea that women aren't so good at the technical stuff. It's so common for women to get moved either sideways, so moving from developer to BA, for instance, or just get

promoted to team leader and moved out of technical roles. (Denise, Senior Software Engineer)

Much as I really wanted to get into doing some coding, I found I was very heavily pushed towards the sort of team lead roles or the administrative side of things. (Wanda, IT Business Analyst)

They recognised that moving women into these hybrid roles could dilute the presence of women in technical roles, which were more highly valued and rewarded. ‘Creative genius’ roles were male preserves (Bevan and Gatrell, 2017).

There is this drive now to get girls into technical roles . . . but they are pushed . . . into . . . fringe roles . . . Not hardcore technical roles that bring money and respect. (Barbara, IT Security Professional)

Therefore, they adopted a dynamic strategic approach to the salience of their gender identity and its use, enabling them to navigate the increasingly male-dominated occupation they encountered.

Geek and female mismatch in IT

Twenty-six of the women referred to a geek/nerd masculine culture that included the need to be both knowledgeable and obsessive about IT, which could be challenging at times. Some found it more difficult to relate to.

If you come in and don't know what you are talking about, you'll have a really tough time. (Cassandra, Team Leader and Software Developer)

And this kind of fan culture . . . I found very difficult. . . it's very off-putting.

(Heidi, ex-Software Developer)

Others argued that the geek/nerd culture was less valuable than many in the industry seemed to think and that it could lead to a lack of productivity. Echoing the 'tools and toys' dichotomy (Kelan, 2007b), they contrasted themselves with their male colleagues, whom they saw as having a closer and more obsessive relationship with technology. However, they argued that having a more instrumental relationship with technology could be more effective and waste less productive time.

Management liked me because I solved problems . . . most of my [male] peers would have been more technically focused. If they were given a project to do, they would have been interested in what new technology they might pick to get to learn to do the project . . . Some of the things that people get up to in terms of useless work in software companies is just dreadful. (Heidi, ex-Software Developer)

Not all the women experienced this geek culture as negative. Five women argued that geeky males were actually easier to work with than less geeky ones, as they were keener to collaborate and share their knowledge. Interestingly, these women tended to be those with a high degree of technical ability and worked as managers of largely male technical teams. These women had proven their technical prowess and were in positions of authority over technical males and felt accepted.

One of the reasons that I like working in IT is because the men in IT are generally nicer than average . . . They're not interested in being macho or doing you down because you are a woman . . . my experience of working with men has been positive. I have never been attacked or belittled or I have never felt under physical threat. If I worked on a building site, I'd hate it. (Denice, Senior Software Engineer)

However, the agency of these technical women did not lead to radical changes in the gender structure (Kalev, 2018; Wynn and Correll, 2018) because they were absorbed into the existing narrative in several ways. First, although technical women exist, they have become a rare minority in IT (e.g., the 'unicorn' comment above). The participants in their 50s and 60s indicated that this was a more recent development. When they started their careers in IT, there were more women in technical roles. Second, seven respondents discussed how women who performed technical work were sometimes seen as different from other women and, in some ways, un-sexed (Höpfl and Matilal, 2007; Wolkowitz, 2006).

The most uncomfortable I've been is seeing other women treated in ways that I'm not. That's more confusing as well, because that's the point where you realise they see you as one of the boys, and you don't want to be one of the boys; you want them to see you as who you are. Probably the most socially isolating thing is the realisation that people aren't willing to accept my gender, because I don't represent things that they think my gender should represent. (Violet, IT Support Professional)

Sometimes, we'd go and sit for a coffee and the blokes might eye up one of the women . . . walking past. I'd usually pull them up and they'd say . . . 'Oh well, you don't count. You're just one of us'. . . . It obviously shows they accept me, but there's part of me that thinks, 'Well, yes, but that's at the expense of me being seen as a woman'. (Raine, IT Systems Administrator)

Drawing on the accounts of the participants, technical women were seen by male colleagues to be particularly special, so they were steered towards technical and managerial roles, which is why the women considered themselves to be more welcome or accepted in these roles. In return, the women reinforced this view by acting as 'superwomen' to some extent and also considering themselves different – more special than men and many other women. Twenty-three of the women reflected on these strengths and saw themselves as being able to handle people management as well as technical work better than many of their male peers.

I'm the only woman on it, because it's a technical team, but nobody gives me any grief for it. They all really know better than to take me on . . . They all know that I know more about it than they do, nobody would ever question the fact that it was a woman leading the team; that just wouldn't enter their heads at [COMPANY], I don't think. (Daphne, IT Consultant)

In essence, technical women did not really exist for many of their male colleagues, so the women were pushed or felt pushed through the prevailing gendered structure into mixed roles. They either ran the risk of continuing to represent women in technical roles or took up management positions to effect change from within. By occupying these roles, they found that they were primarily able to effect peripheral micro-level change rather than substantive

meso-level transformations because of the firmly embedded gender regime structures in place. Change is therefore likely to occur without broader, more incisive interventions and action from the ranks of the selected women to build relations and interactively propagate strategies for navigating IT roles. Such action would benefit from male support at every level but would require the erosion of existing gender identities and norms.

Discussion and conclusions

The women interviewed for this study operated in heavily male-dominated working environments, where their technical expertise was frequently questioned because of deeply ingrained gender norms, assumptions and biases. The findings revealed how the male-dominated gender structure (Mader, 2016; Risman et al., 2018) framed women's thoughts and feelings about their female gender identity within IT. This in turn affected how they adapted their behaviours, how they reacted to it and how it influenced their conceptions of roles and conduct for women in IT.

We have drawn on ideas of agency and structure in this paper to examine how female IT professionals negotiate their gender identity within a male-dominated and structured industry. We have been able to demonstrate how the industry's gender structure acts as a social structure with particular 'causal powers' for gendered identities, experiences and behaviours (Mader, 2016 p. 442). Our work shows how the reflexivity of the women lead to the reinterpretation and a renegotiation of gender identity within IT. From these, we extracted three important contributions to our understanding of how women navigate careers in a critical frontier for future gender equality.

First, we shed light on the implications of exploring the IT gender structure for the gendered identities of women in IT. We showed that rather than resigning themselves to becoming an ‘it’ in IT (Adams et al., 2006), the women strategically and dynamically displayed their identity as women to counter the potential of being treated as an ‘it’ when they were conscious of this and felt the need to do so. The gendered structure in place communicated a mismatch between their female gender and their presence in IT (Bevan and Gatrell, 2017)). In terms of physical presence, the women initially felt the need to blend in (Haynes, 2012; Höpfl and Matilal, 2007), but, over time, those women who saw the importance of displaying femininity reasserted their physical presence as part of the social process of dynamically relating their gender identity to the gender structure they encountered.

However, even women who presented themselves in less stereotypically feminine ways found that they did not always fit the mould of a technically skilled IT worker. According to the participants, many of their colleagues saw femininity and technical ability as virtually incompatible. In addition, their behaviours reflected the need for them to sometimes be assertive to ensure that their contributions to projects were being taken seriously and recognised by the men they worked with even if this may not be well received by male colleagues (Babcock and Laschever, 2003; Heilman and Eagly, 2008). These findings contribute to our understanding of how a heavily masculinised gender structure (Risman et al., 2018), such as the one in IT, steers attention to the bodies of those performing the work rather than the nature of the work itself, such as algorithmic programming, which is gender-neutral. Arguably this gender structure may also affect how consumers interact with technology. Leavy (2018) discusses the problem of gender bias in artificial intelligence and how this biases the data being used in machine learning and the algorithms being used to underpin everyday life. For example, the absence of female IT professionals has led to blind

spots in technology product development, such as voice recognition systems that struggle to follow female voices (Reynolds, 2017).

Second, we strengthened theoretical insights into the relationship between the gender structure and individual agency (Kalev, 2018; McCarthy and Noon, 2018; Risman et al., 2018; Wynn and Correll, 2018). Our data provided an understanding of how the women viewed the carving out of hybrid roles for them and some of the underlying essentialist perspectives around their nurturing strengths and capabilities (Heilman and Eagly, 2008; McCarthy and Noon, 2018). Interestingly, they both accepted and rejected these developments, presenting conflicting tensions. This was because they saw themselves as women through the eyes of males and judged themselves accordingly, but at the same time, they wanted to see talented women in technical IT work and knew that gender was not a legitimate barrier to women's participation in IT. Consequently, they felt the need to maintain and repair their gender identity in response to emerging challenges from the gender structure.

Focusing on the way the gender structure influenced their agency, we could argue that these essentialist beliefs emerged from their interactions with their working environment. To some extent, this appeared to be the case; however, their beliefs were also shaped by wider gender-related cultural factors beyond the IT gender structure – indicating that the relationship between the gender structure and their agency is affected by the nuanced combination of multiple influences. The reflexivity demonstrated by the women supported Archer's arguments concerning the irreducibility of agency and structure (Archer, 1995, 2007) and illustrated how pre-existing ideas of gender shape the gender structure in IT. The women had to navigate an industry that positioned them as less technical and better suited to specific

roles. Although the women challenged and sought to disrupt these views (Kalev, 2018; McCarthy and Noon, 2018; Wynn and Correll, 2018), their own reflexivity, influenced by the broader societal gender order and their minority status within the industry, hampered their responses and precluded a more effectual role in shaping and changing the IT gender structure.

These findings promote thinking beyond how women might detach themselves from work or from their femininity in IT (Griffith and Moore, 2010; Kelan, 2007a). We instead see not only how male-dominated occupational-organisational cultures largely serve to place women outside the industry but also how women then seek to reattach themselves by finding ways to connect their gendered identities to their work. The women in the study had a wide range of interesting and challenging roles and mostly enjoyed their work and found it meaningful. They continued to be motivated by their enjoyment of their tasks to find ways to reposition themselves as women within IT and reconcile their individual, gender and professional identities.

Third, by providing a deeper insight into the nature of the IT gender structure, we uncovered how the field is able to maintain itself despite interactions involving technically skilled women. Our data elucidated how technically skilled women encounter the gender structure in IT, and how, despite their skills and attempts to interrupt this structure (Kalev, 2018; McCarthy and Noon, 2018; Wynn and Correll, 2018), they are effectively subsumed within it and the overall narrative of women lacking technical ability remains largely intact. We demonstrated how the gender structure underestimates women's technical abilities and therefore pushes them towards or rewards them for taking hybrid roles and thus minimises the presence of technically skilled females. When the presence of technical women cannot be

denied, the IT gender structure then considers them as rare anomalies. Thus, we revealed that despite the efforts and achievements of the individual women we interviewed, the gender structure in IT underplays their very existence and remains largely undisturbed.

Limitations associated with the study included the acquisition of a single sex perspective. Future researchers ought to observe gendered behaviours in IT and gain insight into men's attitudes and behaviours towards women as well and if and how they are changing (Kalev, 2018; Wynn and Correll, 2018). This is urgently needed given renewed concerns about toxic male behaviours towards female colleagues and the impact of masculinity in male-dominated sectors such as information technology (Berdahl et al., 2018).

As the cultural significance of the IT industry has grown, there has been a renewed focus on its workforce composition and shortage of female talent. It would be informative to examine whether this has resulted in increased reflexivity over how gender is conceptualised in IT by the majority male workforce.

In addition, we must seek to unpack the way in which women are managed and mentored in IT to understand the practices to be adopted to retain and support them. Despite many challenging experiences, the women in the sample had broadly achieved good career progressions and their mentors and managers were supportive and influential, especially in the early years of their careers. Highlighting helpful practices that help women navigate the gender structure could be a valuable aid to retention. The insights provided by this research are likely to be useful to organisational leaders (especially those in other heavily male-dominated sectors) seeking to make their organisation or internal units more diverse, inclusive and equitable.

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Table 1 Participants and their job roles and work contexts

Category or job role	N	Age brackets* 20s=2 30s=10 40s=27 50s=15 60s=2	Work context when interviewed
Business Analysis	11	30s – 50s	Participants worked in Education; Energy; Financial Services; Health; Local Government; Media Oil and Gas; Professional Services; Publishing. Two were self-employed. Five had previously worked as the sole female in their work units. Their current work units ranged from 7% to 40% female.
Consultancy	9	20s – 60s	Participants worked in IT companies (7)and Telecoms. One was self-employed. Two had worked as the sole female in their work units. Their current work units ranged from 9% to 40% female.
Development and architecture	11	20s – 50s	Participants worked in Central Government; E-Commerce; Financial Services; IT Companies (2); Legal; Publishing; Retail; Telecoms. Two were self-employed. Six were currently or had previously worked as the sole female in their work units. Their current work units ranged from being the only female to 29% female.
IT security	8	30s - 40s	Participants worked in Energy (4); Financial Services; an IT Company; and Telecoms (2). Six had been or were currently the sole female in their work units. Their current work units ranged from being the only female to 30% female.
Project management	8	30s – 50s	Participants worked in the Arts; Energy (3) an IT Company; Financial Services; Pharmaceutical. One was self-employed. One had previously worked as a sole female in their work unit. Their current work units ranged from 'male-dominated' to 50% female.
Senior management	7	40s – 50s	Participants worked in Distribution (2); IT Companies (4); and Media. Two were currently or had previously worked as the sole female in their work units. Their current work units ranged from being the only female to 40% female.
Service management (incl. Systems Management and IT support)	3	30s - 50s	Participants worked in Central Government; Local Government; and Telecoms. One had worked as a sole female. Current work units were 5% female to 'predominantly female'.

Notes: *Number of participants in each age bracket. IT = information technology.

Table 2: Main themes and codes used in the analysis of the women's experiences of working in information technology (IT)

Main theme	Description	Example codes
Experiencing an IT career	Differing factors influencing the way in which the IT career is experienced	<ul style="list-style-type: none">• Career satisfaction or success• Motivation and enjoyment in an IT career• Organizational or industry culture• Professional identity
Gendered experiences whilst working in IT	How participants experienced gender whilst working in IT	<ul style="list-style-type: none">• Conduct in a male dominated environment• Essentialism<ul style="list-style-type: none">○ Gendered roles for women○ Gendered roles for men○ Gendered behaviour comparisons• Fit and belonging in IT• Femininity in IT

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