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WOMEN IN INFORMATION TECHNOLOGY CAREERS: A PERSON-PROCESS-CONTEXT-TIME FRAMEWORK

Klara Nelson

Natasha Veltri

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Nelson, Klara, The University of Tampa, 401 W. Kennedy Blvd., Tampa, FL 33606, USA, krnelson@ut.edu

Veltri, Natasha, The University of Tampa, 401 W. Kennedy Blvd., Tampa, FL 33606, USA, nveltri@ut.edu

Abstract

The underrepresentation of women in IT is a research area that has received much attention in recent years. Extant research has examined many factors that contribute to and/or improve the widening gender gap. Review articles to date have focused on certain aspects of the field, e.g., the pipeline (Gürer and Camp, 2001), secondary and post-secondary education (Sanders, 2005; Singh, Allen, Scheckler, and Darlington, 2007), and women in IT careers (Ahuja, 2002). There is a need for a comprehensive framework that synthesizes and extends existing research using a new research lens. We propose an integrative organizing model that draws on the career theory literature, Bronfenbrenner's ecological system theory (Bronfenbrenner, 2004), the relational model of career decisions (Mainiero and Sullivan, 2005), and Super's life-span, life-space approach to career development (Super, 1990). Examples of how the framework can be applied are discussed.

Keywords: IT careers, gender and IT, women careers.

1 Introduction

In the last one hundred years women have enjoyed a more prominent role in the society, increasingly influencing social, cultural, economic and political spheres. The number of women in the workforce has grown steadily around the world with strong representation of women in many careers. Women account for 58% of college graduates in the UK, 65% in the United Arab Emirates, 58 % in the USA, 60% in Brazil, and 47% in China (Weiberg, 2010). Women have found their way into many male-dominated fields, even leading to a so-called "gender switch" in some, such as TV news broadcasting (Weibel, Wissmath, and Groner, 2008). Further, women have made significant strides into leadership positions both in private and public sectors: in 2010 women accounted for 19.1% of members of national parliaments worldwide (Inter-parliamentary Union, 2010).

However, there remains an alarming under-representation of women in computing-related majors and careers. Based on the data from 2007 the percentage of women receiving first and second tertiary degrees in computing is quite low in Europe: 10.2% in Switzerland, 16.7% in Germany, 19.7% in the UK, 21.3% in Italy and 29.8% in Sweden (Eurostat, 2009). Similarly, in the United States workforce only 26.67% of computer specialists are women (U.S. Census Bureau's American Community Survey, 2005 – 2007). This gender gap is widening as interest among women in courses and careers in information technology is declining. Margolis and Stockard (2005) conclude that "the fields of IT and computer science have in effect become gendered 'male'". At the same time, there are multiple benefits to equal gender representation in the workforce. For instance, 72% of respondents to a recent McKinsey study believed there was a link between gender diversity in leadership and company's financial performance (McKinsey Quarterly, 2010). Additionally, a historical review of women in computer science shows that "computing is not inherently a male domain, but rather a socially constructed stereotype" (Taylor, 2005).

There have been many calls for action to narrow the gender gap as the lack of women in technology jobs may lead to less technology innovation and affect the competitiveness of companies globally (Ahuja, 2002; Armstrong, 2009; Mearian, 2007). Consequently, the topic of women in IT has been the focus of many academic and practitioner articles over the past 15 years or so (see review articles by Ahuja, 2002; Gürer and Camp 2001; Sanders, 2005; and Singh, Allen, Scheckler, and Darlington, 2007). Extant research has focused on many factors and distinct pieces of the gender gap puzzle such as the pipeline problem (Gürer and Camp, 2001), secondary/post-secondary education and determinants of career choice (Adya and Kaiser, 2005; Sanders, 2005; Singh, Allen, Scheckler, and Darlington, 2007), and women in IT careers (Ahuja, 2002). This paper introduces an overarching comprehensive framework to integrate and extend existing research. The framework we propose may be used to catalogue the existing research base and highlight under-researched areas as well as enable scholars to generate hypotheses and position their studies within the growing body of literature on women in IT.

2 The Women in IT Literature

2.1 The Pipeline Metaphor

One frequently cited phenomenon for the underrepresentation of women in IT is the "incredible shrinking pipeline" (Gürer and Camp, 2001) which disproportionately and at all stages leaks female students from middle and high-school through college to graduate schools and IT careers in academia or industry. High school students with interest and aptitude in IT choose another major, students begin majoring in IT but then select another area of study before graduation, and students graduating with an IT degree choose another field as a career (Blickenstaff, 2005; Gürer and Camp, 2001). A host of factors contribute to weak joints in the educational pipeline including attitudes towards math and

science, absence of female role models, pedagogy and cultural pressures, and many others (Blickenstaff, 2005; Varma and Hahn, 2008). Stereotypes about gender roles and IT as an occupation are increasingly influential, reducing young girls' interests in IT as a field of study or a career (Clayton, von Hellens, and Nielsen, 2009). Social pressures and stereotyping could also lead girls to underperform despite high aptitude in IT (Rosenbloom, Ash, Dupont, and Coder, 2008). Other factors in the educational pipeline include societal influences; age, stage, and pipeline issues; experience, attitude and use patterns; and issues in the classroom (Sanders, 2005). Creamer, Lee, and Meszaros (2006) studied nine variables associated with women's interest and choice of IT careers: information credibility, receptivity, information source, decision orientation, computer use, IT attitudes, parental support, and background characteristics.

Drawn from Social Cognitive Theory, a recurring theme in explaining women's success in computer science and career decisions has been the concept of self-efficacy (Blaisdell, 1998; Brinkley and Joshi, 2005; Michie and Nelson, 2006; Wilson, 2002) defined as an "individual's estimate or personal judgment of his or her ability to succeed in reaching a specific goal (Brinkley and Joshi, 2005, p. 27). In the context of IT, self-efficacy usually refers to "an individual's perceptions about her or his computer-related and IT-related abilities" (Brinkley and Joshi, 2005, p. 27) or the individuals' belief of their ability to perform across multiple computer related tasks (Marakas, Yi, and Johnson, 1998). Research shows that women report lower levels of computer self-efficacy (Johnson, Stone, and Phillips, 2008). Women are also more likely to attribute responsibility for their performance to computers and believe that computers determine the outcomes of their interactions with technology, because they are more social than men in their interactions with IT (Johnson, Veltri, and Hornik, 2008). Computer self-efficacy impacts attitudes towards IT which in turn influences IT career intentions. Margolis and Fisher (2002) found that the geek culture of computing undermined women's interest in computing and their confidence in being able to succeed in it.

The pipeline issues and gender imbalance in the USA have been characterized as a cultural problem that is not universal (Adams, Bauer, and Baichoo, 2003). First-generation college students, women from diverse racial-ethnic backgrounds, and international female students demonstrate different kinds of persistence than do women with economic and race privilege (Singh, Allen, Scheckler, and Darlingon, 2007). Minority women are also less likely to resent being associated with the geek culture due to lower social and economic status (Varma, 2007). Instead, minority women's exit from IT is often explained by more practical considerations related to familial, social, and economic conditions (Varma, 2007). Research thus shows that "women interested in computer-related fields are not a monolithic group, do not bring the same kinds of economic and social resources to the academic arena, and do not face the same kinds of pressures to succeed. These factors interact in previously unanticipated ways …" (Singh, Allen, Scheckler, and Darlington, 2007, p. 517). This is also true for women who have entered the IT career pipeline (Trauth, Quesenberry, and Huang, 2009).

2.2 Women in IT Careers

There is consensus in the literature that women's career development in general is more complex than that of men's as they face a number of internal and external barriers that complicate and limit their career choices and advancement (Coogan and Chen, 2007). Women's careers comprise more than work, and are embedded in larger life contexts where families continue to be liabilities to women's career development in organizations (O'Neil, Hopkins, and Bilimoria, 2008). As such, traditional models of career stages based on men's careers do not fit the complexities of women's careers (Sullivan and Mainiero, 2008). The linear notion of the pipeline does not match well with career paths for women, which reflect a wide range and variety of patterns (Burger and Aspray, 2007; O'Neil et al, 2008; Leventman, 2007).

Consistent with the view that "the field of information technology is a roadway with many on-ramps" (Turner, Bernt, and Pecora, 2002, p. 16), Leventman and Finley (2005) identified three pathways to IT careers. Women following the traditional pathway had technical undergraduate degrees and decided

on and pursued a technical career in high school and college. The transitional route involved non-IT bachelor's degrees and jobs, and the pursuit of a master's degree program to enable an IT career transition. On the self-directed path, women had nontechnical educational and occupational backgrounds, and slid into IT positions. Not surprisingly, a study of prototypical career paths of IT professionals found no gender differences for the protean career type characterized by a sequence of jobs in multiple occupations (Joseph, Ang, and Slaughter, 2005). These findings are consistent with research by Coder, Rosenbloom, Ash, and Dupont (2009) who found women in IT were significantly less likely than men or women in non-IT careers to be influenced by high-school courses or teachers in choosing that career: many "had 'fallen into' their IT careers … by way of another career field", and did not hold computer science degrees (Coder, Rosenbloom, Ash, and Dupont, 2009, p. 27). It is also interesting to note that unlike men, more women enter the IT profession because of factors not specific to the IT profession such as job security, flexible work hours, and ease of entry (McKinney, Wilson, Brooks, O'Leary-Kelly, and Hardgrave, 2008). Furthermore, a study by Quesenberry and Trauth (2008) highlights the complex nature of career anchors as women move through their IT careers. Specifically, women were typically aligned with more than one career anchor that cluster, dynamically, over time. Quesenberry and Trauth's findings are in line with the ABC model of kaleidoscope careers for women, which stipulates that the three parameters that dominate choices about the fit of their lives and careers – authenticity, balance, and challenge – shift over a woman professional's life span (Mainiero and Sullivan, 2005). Other critical factors for women's career development include human and social capital (O'Neil et al., 2008). Unfortunately, women are often confronted with a "chilly" or even "hostile" cultural climate in many IT work organizations (Margolis and Fisher, 2002; Roldan, Soe, and Yakura, 2004), and an occupational culture that seems to privilege male workers and their competencies, regardless of the skills possessed by women (Woodfield, 2002; Bagilhole, Powell, Barnard, and Dainty, 2007). Other top barriers to career advancement for women in IT include the lack of role models in the company similar to themselves, lack of a mentor, sponsor, or champion who makes accomplishments known to important people in the company, and exclusion from the important networks of key decision-makers (Catalyst, 2008).

Not surprisingly then, women not only report a lower intention to stay than men (Igbaria and Chidambaram 1997), but many leave their jobs: the female attrition rate for women in technology fields is 56% (Hewlett, Luce, Servon, Sherbin, Shiller, Sosnovich, and Sumberg, 2008). At the same time, research regarding career satisfaction yields mixed results. One study found that women in more traditional, female occupations were significantly more satisfied with their career choice than IT professionals (Geigner and Crow, 2003). Other studies found similar levels of satisfaction with their IT careers for male and female IT professionals (Igbaria and Chidambaram, 1997; McKinney et al., 2008). Ballou and Huguenard (2008) found gender effects regarding job satisfaction varied by position. While female IS managers were significantly more satisfied with their career choice than their male counterparts, differences between satisfaction ratings of male and female programmer/analysts and consultants were small.

3 An Integrative framework

As discussed above, the topic of women in IT is a "highly complex cultural issue" (Svinth, 2006) with many faces, and it is affected by a range of subtle and overt influences including the environmental context, gender, race, class, career decisions, work-life balance issues, social networks, and organizational factors (Trauth, 2002, 2009). Review articles to date have focused on certain aspects of the field, e.g., the pipeline (Gürer and Camp, 2001), secondary and post-secondary education (Sanders, 2005; Singh, Allen, Scheckler, and Darlington, 2007), and women in IT careers (Ahuja, 2002). There is a need for an overarching framework that synthesizes and extends existing research using a new research lens. We propose the comprehensive model in Figure 1 that draws on the career theory literature including applications of behavioral decision making theory to career choices (Gati and Asher, 2001), Bronfenbrenner's ecological system theory applied to career development

(Bronfenbrenner, 2004; McMahon, 2005), a relational model of career decisions (Mainiero and Sullivan, 2005), and Super's life-span, life-space approach to career development (Super, 1990).

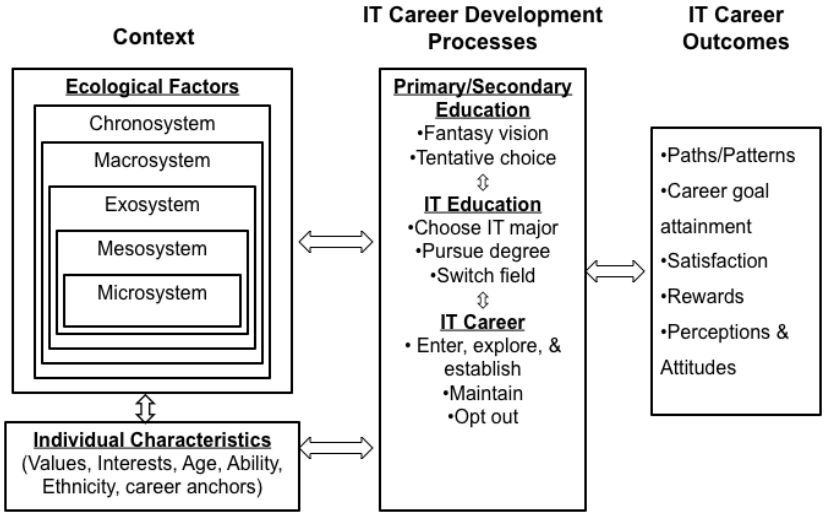

Figure 1. A Person-Process-Context-Time Approach to Understanding Women in IT

The framework shown in Figure 1 combines both process and factor approaches to embrace the complexities of career development of women in IT. Unlike the linear and incomplete pipeline model, the decision-making approach is dynamic and views women's' IT career development as a set of decision processes (e.g., choosing a college major, choosing IT as an occupation, choosing to opt out of an IT career). Aspects of career decision-making emerge early on when a child dreams of what she or he may want to be one day (Sauerman, 2005). These decision-making processes occur as individuals recycle through Super's (1990) life career development stages of growth, exploration, establishment, maintenance, and disengagement.

A host of individual differences can act as enablers or inhibitors of the IT career development process. Furthermore, the ecological approach to career development views an individual and their behaviors as "a representation of the complex interaction among the myriad factors that constitute her or his life, referred to as the *ecosystem"* (Cook, Heppner, and O'Brien, 2002, p. 296).

Ecological factors associated with five major subsystems influence human behavior (Bronfenbrenner, 2004). The *microsystem* includes personal interactions with people in the most proximal environments such as the home, school, peers, or the work setting. *Mesosystems* capture interactions between two or more microsystems, e.g., the relations between an individual's home and school environments. *Exosystems* are linkages between subsystems that indirectly influence the individual's immediate context such mass media, neighbors, friends of the family, etc. The *macrosystem* refers to the attitudes and ideologies of the cultural environment in which an individual lives. Finally, the *chronosystem* describes the patterning of environmental events and transitions over the life course, as well as socio-historical circumstances (Bronfenbrenner, 2004; Cook et al., 2002).

The model in Figure 1 also shows a number of different IT career outcomes (e.g., career patterns or satisfaction) that result from the dynamic person-process-context-time interactions.

4 Discussion and Future Research

The alternative representation of Figure 1 as a matrix (Figure 2) can serve as a template for examining past research to prepare for the future by gaining a richer understanding of the complex phenomenon of women in IT (Webster and Watson, 2002).

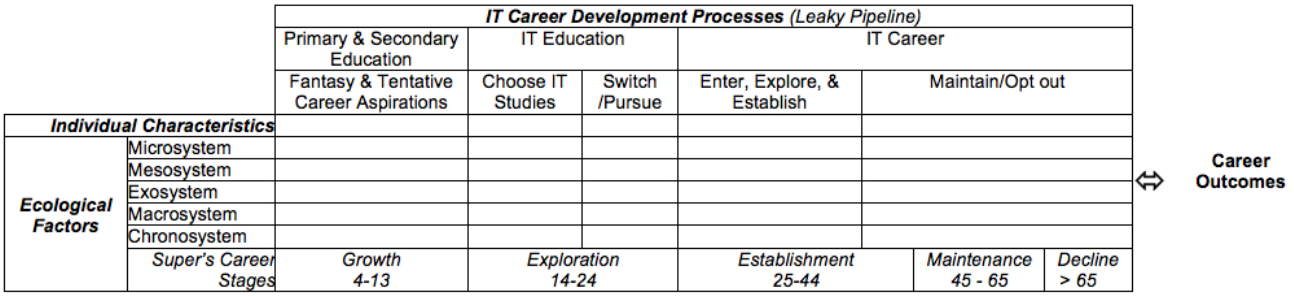

Figure 2. A Person-Process-Context-Time Matrix for Understanding Women in IT

Specifically, we see three applications of the research model:

- To enable scholars to position their studies within the growing body of literature on women in IT;
- To catalogue the existing research base on women in IT and highlight under-researched areas similar to the models for research in computer-based management information systems proposed by Ives, Hamilton, and Davis (1980) and information systems implementation by Kwon and Zmud (1987); and
- To review research related to a specific process, individual characteristic or ecological factor, or their interaction(s), and generate hypotheses for future research.

4.1 Applying the Framework To Catalogue Recent Research

We reviewed and categorized several articles to illustrate the possible cataloging of existing research on women in IT (Figure 3). Habashi, Graziano, Evangelou and Ngambeki (2009) examined the role of elementary and middle school teachers in forming their students' person-thing orientation, which measures student's interest in science, technology and math careers. This study of 3rd and 6th graders focused on the earliest career stage of 'growth' and the first segment of the pipeline – 'primary and secondary education'. It is one of very few studies addressing the earliest stage of career development and included both individual (person-thing orientation) and microsystem (teacher's role) factors. The Heinze and Hu (2009) article investigated the factors that influence the decision of undergraduate students to pursue an IT major and thus falls into 'IT education' component of the pipeline and 'exploration' career stage. This study examined the influence of several individual characteristics (attitude towards IT major, computer self-efficacy, perceived behavioral control) and exosystem (subjective norm) and macrosystem factors (perceived IT job availability as part of the national economy) on the intention to pursue IT major. The study of women retention in the IT workforce in the U.S. by Trauth, Quesenberry and Huang (2009) maps into the Super's life career development stage of 'establishment' and 'IT career' segment of the pipeline. The authors examined several individual characteristics such as age, ethnicity, race, education and work histories, interests, abilities and personality traits. They also focused on many ecological factors that can be mapped into four different ecological subsystems: mentoring and management support associated with a microsystem; work-life balance and social networks associated with a mesosystem; and gender stereotypes and occupational culture are associated with an exosystem/macrosytem. Finally, Wentling and Thomas (2009) examine the impact of the workplace culture (microsystem) on the career development of women in IT. Since women ranged in age from 26 to 55, and lack of participation in top level positions emerged as one of the factors, we include this study in the maintain/opt out phase of IT careers.

		IT Career Development Processes (Leaky Pipeline)					
		Primary & Secondary Education	IT Education		IT Career		
		Fantasy & Tentative Career Aspirations	Choose IT Studies	Switch/ Pursue	Enter, Explore, & Establish	Maintain/Opt out	
Individual Characteristics		Habashi et al. (2009)	Heinze & Hu (2009)		Trauth et al. (2009)		
Ecological Factors	Microsystem	Habashi et al. (2009)				Wentling & Thomas (2009)	
	Mesosystem				Trauth et al. (2009)		
	Exosystem		Heinze & Hu (2009)		Trauth et al. (2009)		
	Macrosystem		Heinze & Hu (2009)		Trauth et al. (2009)		
	Chronosystem						
Super's Career Stages		Growth 4-13	Exploration 14-24		Establishment 25-44	Maintenance 45 - 65	Decline > 65

⇔ Career Outcomes

Figure 3. Example of Mapping Recent Research to Career Stages and Ecological Factors

4.2 Applying the Framework to Review Specific Topics

We focus on *vocational interests* (individual characteristic) and *culture* (macrosystem) to illustrate the use of our framework for reviewing research of a topic over the entire span of IT career development.

4.2.1 Vocational interests

Vocational interests appear to play a crucial role in gendered occupational choices and gender disparity in the IT field (Su, Rounds, and Armstrong, 2009). Interests, the "coherent and enduring cognitive structures that, minimally, are characterized by patterns of likes and dislikes of activities" (Tracey, 2002), are a driving force behind the selection and maintenance of occupational careers (Holland, 1997). Achieving maximal congruence between interests and occupations is at the heart of career counseling and interventions (Tracey and Sodano, 2008) which are based on models of interests such as Holland's hexagon or circumplex structural model of personality/occupational types (Holland, 1997) and Prediger's *data-ideas* (D/I) and *things-people* (T/P) extension of the model (Prediger, Swaney, and Mau, 1993). There are substantial gender differences in vocational interests along the *things-people* dimension with women gravitating towards people-oriented careers and men gravitating towards things-oriented careers (Su and Armstrong, 2009) such as computer-related jobs (Computer Programmer; Computer Systems Analyst; Web Site Developer) which are associated with Holland's *R (realistic)* dimension and Prediger's *Things* dimension on the World-of-Work Map (American College Testing).

Starting with the primary and secondary education processes significant gender differences between male and female interest patterns that are consequential for IT-related academic and career choices have been determined as early at the 3rd grade (Habashi et al., 2009). Furthermore, interest scores change over time in a V pattern with high scores for all types of interests in elementary school, a drop in middle school (especially upon entry to it), and then an increase through high school with a possible drop in the senior year (Tracey and Sodano, 2008). There are clear gender differences with greater drops for girls than boys with entry into middle and high school, specifically in the Holland's *I (investigative*) area which is related to scientific occupations (Tracey and Sodano, 2008). Related to the IT Education process, interests not only affect the choice of entering a major (Porter and Umbach, 2006), but also persisting in it (Allen and Robbins, 2008). Continuing on with the IT Career process, congruence between interests and career choices plays a role in satisfaction with one's career, as well as switching careers. It is worthy to note that interests remain relatively stable from age 12 or eighth grade (the end of the Super's Growth stage) to age 40 for both males and females (Low, Yoon, Roberts, and Rounds, 2005), which coincides with Super's Establish/Maintenance stages in Figure 2.

4.2.2 Culture

Previous research has shown the importance of including a cultural perspective in gender and IT research (Trauth et al., 2008). A study of teenage girls and boys' attitudes of IT and IT careers in secondary schools in five countries in Europe confirms the persisting gender gap, but shows differences between the countries (Gras-Velazquez, Joyce, and Debry, 2009). The percentage of boys and girls interested in IT was about the same in Poland, the UK, and Italy. However, the dropout rate – percentage of students who despite liking IT, do not plan to continue studying it at the tertiary level – was highest for Italian girls (61%) and Dutch girls (54%), and lowest for French girls (24%). At the tertiary IT education level females accounted for 64.34% of graduates from IT colleges in Bahrain in 2009 (Al Sebaie, 2010). Similarly, the percentage of female students in Malaysia pursuing bachelor's degrees in computer science or information technology often exceeds the number of male students (Othman and Latih, 2006). Furthermore, females not only had a more positive attitude towards and perception of IT, they also more frequently had plans to work in the IT industry upon graduation than did the male students. Cultural factors influencing career choices for women in the IT workforce include perceptions of a woman's role embedded in the society as well as socio-cultural moderators such as gendered career norms or gender stereotypes about aptitude (Trauth et al., 2008). Comparing career choices and experiences of South Asian women in the US IT workforce with American women IT professionals, Adya (2008) proposed that most South Asian women did not see their career choice as masculine or believed that gender stereotyping existed in the workplace due to the greater power-distance orientation of their national culture. Furthermore, and consistent with the collectivist nature of South Asian countries, South Asian women were strongly influenced by parents and family in their career choice, while American women attributed their choice of IT careers to peers or a chance encounter with IT-related work or coursework (Adya, 2008). One of the major barriers for Chinese women's career development in IT is the work-life conflict reflecting the influence of traditional Chinese culture which continues to affect modern Chinese women's attitudes to life (Aaltion and Huang, 2007). As childcare is regarded as the mother's responsibility in the first three years of a child, the childcare system in China is "under construction" compared to western countries.

5 Conclusion

This study introduces an integrative person-process-context-time framework that ties together the many facets of extant research on women in IT and offers examples of possible applications of this framework. As shown, interest in IT and subsequent choice of IT as a major and career are influenced by a variety of individual and ecological factors. Since interest in IT and IT careers is a socially constructed phenomenon (Taylor, 2005), it is critical to identify those social factors that encourage girls and women to pursue studies and careers in IT. Given that women roles and responsibilities change as they progress through various life stages, the women's careers and motivation should be examined in light of different career stages. Further mapping of the body of knowledge on women in IT is needed to provide a comprehensive review of the literature, help identify under-researched areas, generate hypotheses for future research, and recognize opportunities for interventions to narrow the gender gap.

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