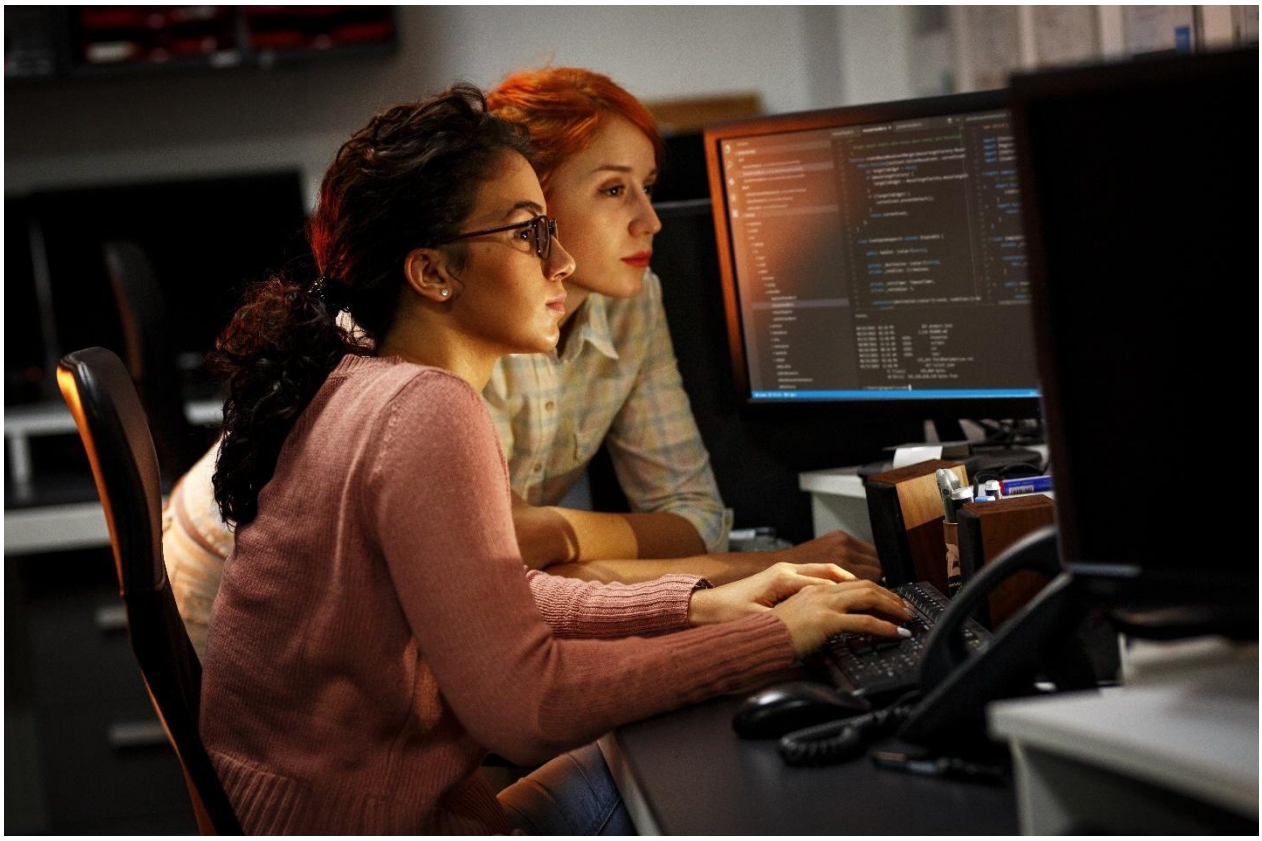
HER TECH

HER TECH – Her Tech, Her Terms. Engagement as the key

D4.1 Literature Review Report



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Her Tech, Her Terms. Engagement as the key

D4.1 Literature Review Report

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	DISSEMINATION LEVEL	
PU	Public, fully open	X
SEN	Sensitive (limited under the GA conditions)	

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CLASS	EU classified, confidential	

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Table of abbreviations

Abbreviation	Description
WP	Work Package

ICT	Information and Communications Technology
STEM	Science, Technology, Engineering, and Mathematics
SDT	Self-Determination Theory
SCCT	Social Cognitive Career Theory
AI	Artificial Intelligence
EU	European Union
CSCL	Computer-Supported Collaborative Learning

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Executive summary

This report presents the results of **the Literature Review**, which aims to (i) identify existing literature on motivational factors influencing women's study and career choices across different generations (Baby Boomers, Generation X, Millennials, Generation Z, Generation Alpha), (ii) identify common themes, differences and evolving trends in motivations over time, (iii) summarise key findings and contextualise them within the broader framework of gender and ICT.

This Report (deliverable D4.1) is an integral part of Work Package 4 (WP4), From Boomers to Alpha: Understanding women's motivations for pursuing ICT as a study and profession. This work contributes to the following specific objectives:

- Identify key factors and actors that influence girls' aspirations to pursue ICT studies and professions in Europe
- Understand the specific features of gender inclusive pedagogy in ICT teaching
- Design and pilot a new gender inclusive teaching framework for ICT

This Work Package builds on the findings and insights generated through previous work carried out within the HER TECH project.

Key findings by cluster

Generation 1 - Baby Boomers (born 1946–1964)

Motivation: driven by *labour-market logic*, not identity: job security, professional prestige, and the practical usefulness of technology (communication, independence, safety). Confidence was the differentiator.

Barriers: almost entirely *structural and exposure-based*: limited access to computing before workforce entry, care/family interruptions, and later, compounding age + gender discrimination once in the workforce.

Generation 2 - Generation X (born 1965–1979)

Motivation: shift from stability toward *professional identity*: whether a woman could see herself as "an engineer," not just someone employed as one. First cohort where pedagogy (collaborative learning design) appears as a distinct component.

Barriers: the first appearance of the **technical/social dualism**: engineering culture rewarded technical mastery over the communication/collaboration skills women more often brought, producing identity-fit tension rather than outright exclusion.

Generation 3 - Millennials (born 1980–1994)

Motivation: career prospects layered with explicit values (meaningful work, societal impact), intergenerational transfer (mothers in STEM, technically-employed fathers), and early-formed self-efficacy.

Barriers: masculine coding of ICT ("geek" stereotype), a persistent confidence gap despite equal performance, and the technical/social dualism sharpening into "managed" professional/gender identity performance.

Generation 4 - Generation Z (born 1995–2010)

Motivation: self-efficacy and belonging, personality traits (Openness), purpose over hierarchical progression, and "stagility" (wanting stability and flexibility simultaneously), and increased concern for mental health and wellbeing.

Barriers: subtle and unconsciously recognised stereotypes; early educational tracking and career choices made before sufficient vocational maturity; lack of belonging in ICT/STEM; AI-related anxiety and fear of automation; underrepresentation despite strong academic performance.

Generation 5 - Gen Alpha

Motivation: framed through Expectancy-Value Theory, autonomous/intrinsic drivers, and role models perceived as attainable and effort-based.

Barriers: stereotype internalisation as early as age seven, a widening motivation-performance gap, and a newly identified barrier: teachers themselves may unintentionally reproduce gendered patterns (higher technostress among female teachers).

Transferable patterns

Transferable patterns across all clusters:

- **The "equality paradox":** strong national equality frameworks consistently coexist with persistent occupational segregation, independent of country or generation.
- **The technical/social (later "things vs. people") divide:** What starts in Gen X as an identity-fit tension and in Millennials as a "managed" performance becomes, by Gen Alpha, shifts towards a fully-formed early-childhood pattern: girls gravitate to people/animal-centred roles, boys to "thing"-centred roles, with technology culturally coded onto the latter.
- **A confidence/belonging gap** that does not track performance: present in every cohort under different names: Boomers ("confidence was the differentiator"), Gen X (identity-fit tension around whether a woman could see herself as "an engineer"), Millennials ("a confidence gap despite equal performance"), Gen Z ("lower levels of belonging despite comparable or higher academic performance"), and Alpha ("a widening motivation-performance gap"). Different vocabulary each generation, the same underlying mechanism: confidence and belonging consistently lag behind actual ability.
- **Family and role-model exposure**, especially maternal, is a consistent and durable predictor of aspiration, from Baby Boomers to Alpha.

- **The stage of life at which the barrier forms has moved earlier with each generation**, moving from workforce entry (Boomers) to primary school (Alpha), which means the effective intervention window has steadily narrowed and shifted towards younger age groups.
- **Formal policy and lived experience remain persistently misaligned**, suggesting legislation alone cannot resolve what is now understood as a largely cultural and psychosocial gap.
- **Retention, not just access, is the recurring endpoint**, across generations, the challenge shifts from getting women in to keeping them, advancing them, and making them belong.

1. Introduction

Methodology

Project partners conducted a structured search using agreed keywords and search strings, including: Women AND ICT careers AND motivation (by generation: Boomer / Gen X / Millennial / Gen Z / Gen Alpha); Girls AND STEM career choice AND generational differences; Gender AND digital career AND barriers AND experiences; Self-determination theory AND STEM AND gender; Role models AND women AND technology career; Work-life balance AND ICT AND women AND generations; Career transition AND women AND technology AND second career.

Selection criteria prioritised sources relevant to partner countries (Belgium, Croatia, Finland, Germany, Ireland, Italy, Sweden) and written in English or local languages (English preferred). Each partner identified at least 5 documents (one per generation) and key data were extracted into a shared literature review database structured around four research questions:

RQ1 - Motivational Factors: What motivational factors attract women to ICT education and careers, and how do these vary across generations from Baby Boomers to Generation Alpha?

RQ2 - Barriers and Challenges: What barriers and obstacles have women faced in pursuing ICT studies and careers across generations, and how have these barriers evolved or persisted over time?

RQ3 - Common Themes and Evolving Trends: What common themes and evolving trends in motivation and barriers can be identified across the five generational cohorts?

RQ4 - Structural and Policy Context: How have EU and national policies, education systems, and workplace cultures shaped women's participation in ICT across generations, and what changes have women experienced in working conditions, workplace culture, and career development over time?

The analysis in this report is therefore a cross-country synthesis of the database entries, grouping findings by generational cohort to support transferability to the next WP4 activities and the final Comparative Analysis Report (D4.4).

Report Structure

This report is organised into five chapters. **Chapter 1** introduces the aims, methodology, background and rationale of the research, and overall structure of the report. **Chapter 2** defines the generational cohorts used throughout, including Baby Boomers (1946–1964), Generation X (1965–1979), Millennials (1980–1994), Generation Z (1995–2010), and Generation Alpha (2010–2025). It also sets out the rationale for a generational lens on women's participation in ICT. **Chapter 3** establishes the theoretical framework, drawing on Self-Determination Theory, the Expectancy-Value Model, Social Cognitive Career Theory, the Science Capital Framework and Intersectionality, to explain how motivation, self-efficacy and belonging interact across life

stages. **Chapter 4** forms the empirical core of the report, examining each generational cohort through a consistent four-part structure: motivational factors, barriers and challenges, policy and national context, and common themes and evolving trends. **Chapter 5** brings the five analyses together in a cross-generational synthesis, highlighting the recurring shifts across cohorts, and factors that remain consistent across generations. The chapter closes with the report's conclusions and policy recommendations.

Background and Rationale

The underrepresentation of women in engineering, ICT and related technological fields has been widely conceptualised as a "leaky pipeline", referring to the gradual exit of women at different stages of education and career development (Mursu et al., 2015). Despite decades of policy interventions and institutional reforms, gender disparities persist, particularly in engineering disciplines where participation rates remain markedly lower than in many other fields (Naukkarinen & Bairoh, 2020). Recent research suggests that the explanatory framework has shifted from structural barriers to more complex interactions between culture, identity, and perceptions of belonging (Bairoh & Naukkarinen, 2023).

Within this context, motivation represents a particularly important entry point for understanding why women choose to enter, remain in, progress within or leave ICT-related education and careers. Motivation influences whether individuals develop an interest in a field, believe they can succeed in it, perceive it as valuable or relevant to their lives, and persist when they encounter difficulties. Existing research on gender and motivation in STEM has examined factors such as self-efficacy, goals, interests and values (e.g. Liu et al., 2009; Marshman et al., 2018; Ratelle et al., 2007). However, findings remain inconsistent: some studies report higher autonomous and lower controlled motivation among women (Ratelle et al., 2007; Vallerand et al., 1992), others find no significant gender differences in situational or contextual motivation (Liu et al., 2009; Vecchione et al., 2014), while others report less positive motivational patterns among women overall (Hakan & Münire, 2014; Stolk et al., 2021).

These contrasting findings indicate that women's motivation cannot be treated as a single, stable construct or explained through individual interest alone. Rather, it is a multidimensional and dynamic phenomenon shaped by the interaction of personal beliefs, social relationships, educational experiences, workplace conditions, cultural norms and structural opportunities. Motivation is therefore important not only for initial career choice, but also for persistence, professional development and long-term retention in ICT.

A generational perspective adds a further lens to this analysis. If motivation reflects the interaction between internal psychological needs (competence, relatedness and autonomy (Ryan & Deci, 2000)) and external influences that are socially and historically situated (Hattie et al., 2020), then the period in which a woman grew up, encountered technology and made educational or career choices is likely to shape her motivations and experiences. Baby Boomers, Generation X, Millennials, Generation Z and Generation Alpha have encountered different levels of access to technology, different labour-market conditions, changing gender norms, and different expectations regarding education, careers and work–life balance. At the same time, generational categories should not be treated as homogeneous or deterministic: experiences within the same

generation can vary considerably according to socioeconomic background, geography, disability, migration background and other intersecting characteristics. Accordingly, this literature review adopts both a generational and an intersectional perspective to identify common themes, differences and evolving trends in women's motivations to participate in ICT over time.

To complement and enrich the findings of this Report, the next stages of the research will involve a survey and follow-up interviews with people directly involved in the ICT field. By gathering first-hand accounts across generations, the research will explore the motivations, barriers, opportunities and key turning points shaping women's pathways into and within ICT, and how these experiences differ across generations and social contexts. Combining evidence from the literature with lived experience will provide a more comprehensive understanding of women's motivation and participation in ICT over time.

2. Defining "generation" and generational cohorts

This report adopts the sociological reading, aligned with Edmunds and Turner's (2002) definition of a generation as "an age cohort that comes to have social significance by virtue of constituting itself as a cultural identity" (p. 7). Generations are shaped not only by age but by the historical, social, cultural and technological conditions experienced during their formative years (Fadhilah et al., 2026). These shared experiences influence each generation's values, attitudes, communication styles, lifestyles and social identities. As society changes, generations can therefore be understood as cultural categories rather than simple age groups. Technological development, globalisation and digital media have particularly influenced younger generations, affecting how they communicate, interpret cultural norms and engage with traditional values.

For research on women's motivation to pursue ICT, generational categories can therefore help examine how different levels of exposure to digital technologies, education systems, labour-market conditions, and social expectations influence ICT-related interests and career choices.

No absolute consensus exists on exact cut-off years across sources. This report primarily follows (McCrindle, 2012), which divides the population into five cohorts of roughly fifteen years each. This timeframe reflects the period during which a distinct set of shared formative technologies, social markers, and landmark events emerges, while also providing a consistent framework that extends to Generation Alpha.

Generational categories are used in this report as an analytical framework for examining shared formative exposure to technology, education, labour-market conditions, and wider social contexts. They are not intended to imply that all women within the same cohort experience or express motivation in identical ways. Considerable variation exists within each generation according to factors such as country, socioeconomic background, cultural context, and access to education and digital technologies. These within-generation differences are therefore recognised and considered throughout the analysis.

Cohorts Description

1.Baby Boomers (1946–1964)

This section synthesises evidence on Baby Boomers, born between 1946 and 1964, to identify factors that may have encouraged or discouraged women of this generation from pursuing education or careers in ICT.

Baby Boomers grew up during a period of substantial social and economic transformation. Their formative years coincided with economic expansion, the development of welfare systems, improvements in healthcare, and broader access to education. Compared with earlier generations, they generally achieved higher levels of education, accumulated greater wealth, and benefited from better health outcomes.

For women, these changes coincided with growing access to education and employment, alongside a broader cultural shift towards autonomy, equality, and self-expression. Women's participation in the labour force was therefore linked not only to financial necessity, but also to greater independence and the opportunity to shape their own lives and contribute more actively to society

The generation's formative years also overlapped with civil rights activism and the women's equality movement, which challenged traditional gender roles and expanded expectations around women's participation in professional life. Together, these social, educational, and cultural changes created a more favourable environment for women to pursue further education and employment, while also reshaping the choices and aspirations available to them.

Relationship to Technology and Digital Skills

Baby Boomers were introduced to digital technology later in life, having grown up with television and the telephone; Prensky (2001) labels them "digital immigrants," which may explain a preference for structured, expert-led approaches over self-directed experimentation when adopting new tools.

Their formative technological reference points were analogue broadcast media (TV, cassette, radio), and they were drawn to authority figures described as "evidential" and "expert," suggesting this generation approached technical fields such as ICT through formal expertise and credentialed training rather than informal exposure.

Learning and Training Preferences

Baby Boomers are described as preferring a sequential and structured process: learning step by step, focusing on one task at a time, working individually, and approaching learning seriously. They may favour manuals, formal instructions, and direct demonstrations rather than learning new technologies through experimentation. These characteristics are particularly relevant when considering the design of ICT training and digital-skills development for this generation.

Educational attainment rose sharply for this generation: only 37% of the pre-war generation completed more than 12 years of schooling, compared with 62% of early Baby Boomers, with women's gains in education broadening their access to professional occupations (Slagsvold and Hansen, 2021).

Career and Employment Values

Entering the workforce during the post-war economic boom, Baby Boomers prioritised job stability, long-term security, and loyalty to a single employer, seeking career progression internally rather than through job-switching. This a value system likely shaped how they approached any career shift into ICT (BDO Trend Report "The Workforce of Tomorrow", 2025).

Despite relatively modest beginnings, this generation accumulated substantial wealth over their careers (an estimated €800 billion in Belgium alone), and many now continue working part-time past retirement age via flexi-job arrangements in Belgian context ("boomerang boomers"), reflecting sustained workforce engagement into later life (BDO Trend Report "The Workforce of Tomorrow", 2025).

A defining psychological trait of this cohort is a strong sense of personal agency, with the belief that their actions can shape their own circumstances. This perspective is often linked to the optimism and political mobilisation of the 1960s (Slagsvold & Hansen, 2021).

The most relevant Baby Boomer characteristics for the analysis of women in ICT are therefore:

- Greater access to education and professional opportunities
- Strong values of autonomy, equality and self-expression
- Influence of the women's equality movement
- Later exposure to digital technology
- Preference for structured, step-by-step learning
- Preference for career stability and long-term security
- Strong sense of personal agency

2.Generation X (1965–1979)

Generation X is described as a transitional generation between traditional work values and the new era of technology, bridging idealistic Baby Boomers and pragmatic Millennials. They grew up and entered adulthood during a period of early technological development and major socio-political change, which fostered a stronger emphasis on independence and self-sufficiency compared to earlier generations. Today, many hold key management positions and continue to form the backbone of many organisations (Berkup, 2014).

Relationship to Technology and Digital Skills

Gen X was the first generation to use personal computers, having to learn and adapt to rapidly advancing technology as it developed (Berkup, 2014). Their iconic technologies were the VCR, the Walkman, and the IBM PC (1981), making them the first generation whose formative years included the arrival of the personal computer. This suggests their motivation toward ICT was practicality- and application-driven, positioning them as early adopters of computing as a tool for getting things done (Berkup, 2014).

Learning and Training Preferences

Their trusted influencers were "pragmatic practitioners", peers with hands-on experience rather than abstract authority figures. Training focus was practical, built around case studies and real-world application, delivered in a spontaneous, interactive, round-table style; their ideal leaders were "co-ordinating" types ("Doers"). They value structure and hierarchy while also showing practical, down-to-earth attitudes - for example, generally preferring meetings to be short and focused (Berkup, 2014).

Career and Employment Values

As children of workaholic parents, Gen X prioritises "working to live" and seeks a balance between work and family; the flexibility often found in ICT roles aligns with their preference for flexible hours and adapting office work to a home environment. Raised largely as "latchkey children" with both parents working, they developed high self-reliance and are motivated by career improvement, personal development, and the freedom to work independently without constant oversight (Berkup, 2014). Over time, like Baby Boomers, they have placed growing importance on flexibility and work–life balance, though their original expectations and values have remained largely consistent (Ius Laboris, 2025).

The most relevant Generation X characteristics for the analysis of women in ICT are therefore:

- First generation to grow up with personal computers, giving them a practical, hands-on comfort with technology rather than a late or formal introduction to it.
- Preference for practical, peer-based learning, aligning with hands-on ICT skill development. Strong drive for work–life balance, making flexible ICT roles an attractive career option
- High self-reliance and independence, supporting self-directed learning and career growth
- Commitment to continuous personal and professional development, matching ICT's emphasis on skills growth
- Pragmatic and structured mindset viewing ICT as a practical pathway for career advancement

3.Generation Y / Millennials (1980–1994)

Generation Y – commonly called Millennials, Gen Y, Generation Next, Digital Generation, Nexters, Echo Boomers, Trophy Kids, Generation www, Net Generation, or Gen N - the first truly technological and global generation, roughly three times the size of Generation X (Schrode & Warren, 2003). Also called the "Why Generation," because they instinctively look for an answer to "why" when they confront a situation. This highly-educated cohort experienced a transition from tradition to a new era and describe themselves as "free souls" (Berkup, 2014).

Raised by "helicopter parents" who stayed closely involved, protected them, and met their requests, they carry the underlying message "run towards home when things get worse" into their adult and working lives (Fleschner 2007). They are self-reliant, resolved, and hold high personal motivation; they are not afraid of unemployment, trusting their families to support them if needed (Berkup, 2014).

Their most distinctive trait, which differs from other generations, is that they live together with the technology (often use technology in order to carry out the tasks they are commissioned). Another event to have considerably influenced the Ys that was affected by the globalization as a first global generation is the rapid advancement of the information and communication technologies. The Ys are adaptable to change beginning from their early age. We may suggest that their adaptation capacity is high. They are a generation who is able to keep pace with change, even like and want it. They are aware of speed of change. They can fulfil their all sorts of work very quickly (Berkup, 2014).

Relationship to Technology and Digital Skills

This is the first cohort to grow up with the widespread expansion of internet, email, SMS, and later PlayStation/Xbox/iPod – the first true "digital native" generation in a networked sense (McCrindle, 2012). Unlike Baby Boomers, they have experienced digital technologies throughout their lives and are generally comfortable using them across education, work, communication, and leisure.

They are technologically sophisticated, open to innovation, and accustomed to rapid access to information, frequently using several platforms simultaneously and being comfortable with parallel processing,

multitasking, hypertext, and multimedia; visual and graphical information may matter more to them than extended written text (Venter, 2017). Digital communication is central to their social and professional interaction enabling them to maintain continuous contact with wide networks and build national and international connections. However, heavy reliance on electronic communication does not necessarily translate into strong interpersonal skills; members of this generation may prioritise speed over communication quality and experience difficulty with face-to-face interaction or communication lacking traditional non-verbal cues (Venter, 2017).

Learning and Training Preferences

Millennials tend to value collaborative, experiential, and technology-supported learning approaches. They are often influenced by peers, mentors, and shared experiences, and they respond well to training that is interactive, practical, and connected to real-world applications. This suggests that Gen Y's engagement with ICT is supported by collaborative environments, opportunities for continuous development, and a sense of empowerment. Their familiarity with digital tools and online communication also aligns well with ICT learning environments that emphasise collaboration, multimedia resources, and ongoing feedback.

Career and Employment Values

Women in this generation are often motivated by meaningful, interesting, and value-creating careers rather than financial gain alone, preferring technology-integrated companies that let them be innovative and actively involved in company operations. They are characterised as innovative and entrepreneurial, generally preferring to be active participants in company operations rather than passive employees. They possess a global viewpoint and strongly respect diversity which makes them well-suited to the increasingly diverse, globalised ICT environment (Berkup, 2014).

Mentorship and feedback are highly valued, with many Millennials expressing a preference for guidance and support from mentors to help them achieve personal and professional goals. In work and study more broadly, they value support, recognition, and regular feedback; they may challenge authority when they believe they can make a meaningful contribution and expect their ideas and achievements to be acknowledged. They also seek a balance between work/study and personal life and are less focused than Baby Boomers on a single lifelong career goal.

The most relevant Generation X characteristics for the analysis of women in ICT are therefore:

- Lifelong exposure to digital technology and strong information-filtering skills, making ICT part of daily life
- Adaptability and openness to innovation
- Preference for interactive, collaborative, peer-based learning and empowering mentorship
- Motivation by meaningful work and innovation rather than financial reward alone
- High value placed on global outlook and inclusivity (including gender diversity)

- Need for mentorship, recognition, and feedback to support career growth. Emphasis on work–life balance and autonomy

4.Generation Z (1995–2010)

The Generation Z, also called as Children of Internet, Digital Generation, Digital Natives[1], Media Generation, .com Generation, iGen[2] or Instant Online (Levickaite, 2010), was born in a period where digital technologies were increasingly integrated into everyday life. The most distinctive traits of the Generation Z are reliance, freedom, individualism, addiction to technology and speed. Unlike earlier generations that experienced the transition to digital tools, many Gen Z individuals encountered technologies such as smartphones, social media, cloud-based platforms, and online gaming as a normal part of their environment from an early age. Often described as "Digital Natives," they are generally characterised by a high level of familiarity with digital communication, mobile technologies, and online platforms.

Relationship to Technology and Digital Skills

This generation is often described as the "most connected generation (Berkup, 2014). For many Gen Z individuals, technology is perceived less as a separate innovation and more as a routine part of daily activities. Their engagement with ICT is often shaped by digital communities, online resources, peer networks, and self-directed learning opportunities.

The Zs are the children of PC, GSM and Internet. The advancement of technology is another distinctive trait of this generation. Launching of the new innovative Apple products, the Facebook hitting the markets in 2004, the Twitter used by millions of users and other social media such as Instagram, Pinterest and Foursquare have become an important part of life (Berkup, 2014).

Learning and Training Preferences

Gen Z tends to value interactive, technology-supported, and flexible learning approaches. They often engage with user-generated content, online communities, and collaborative platforms as sources of knowledge alongside more traditional forms of learning. Their preferred learning environments are frequently described as multimodal, participatory, and student-centred, with leaders who provide inspiration and encouragement ("Co-creators"). This suggests that Gen Z's motivation to enter ICT may be influenced by opportunities for

[1] The **Digital Natives** term refers to that the members of the Generation Z, unlike the previous generations, were born into the technology instead of being accustomed to it. The generations before the Zs, especially the Generation Y, were not born into the technology but accustomed to using it later though they utilized it actively. They are called as the Digital Immigrants. But the Generation Z, who were born into the technology and considered it as a part of life, are called as the Digital Natives.

[2] With the **iGen naming**, it is referred to the products the Apple company introduced to the market in new Millennium. The Apple launched music player iPod in 2001, the mobile phone iPhone in 2007 and the tablet computer iPad in 2010. The generation is named as iGen as these products are used intensively.

collaboration, creativity, and continuous learning through digital communities such as online forums and open-source projects (McCrindle, 2012).

Career and Employment Values

Gen Z is often characterised as adaptable, comfortable with multitasking, and interested in practical, efficient approaches to work. They may value flexibility, innovation, and personalised career paths rather than strictly traditional or standardised roles (Managing Generations X, Y, and Z in Business Life).

The most relevant Generation Z characteristics for the analysis of women in ICT are therefore:

- Digital familiarity and openness to technology: Growing up with digital technologies makes ICT a familiar part of daily life, with strong comfort using new tools and platforms.
- Self-reliance, autonomy, flexibility and work–life balance
- Continuous learning, development and co-creation
- Peer experience, community and supportive workplaces
- Purpose, inclusion and meaningful work
- Fairness, respect, recognition and communication
- Holistic career motivation

5.Generation Alpha (2010-2025)

Generation Alpha is the first cohort to be born entirely into a hyperconnected, mobile-and-social-media world, with no pre-digital "before" period (Ziatdinov & Cilliers, 2021). Because this generation has not yet fully entered the workforce, empirical research remains limited compared with older generations. This means the section below relies more on educational and early workplace-expectation studies than on the retrospective career-motivation data available for other generations.

Relationship to Technology and Digital Skills

Generation Alpha has experienced digital technologies, including AI, as a normal part of their environment from an early age (Ziatdinov & Cilliers, 2021). This matters for motivation because it shifts the baseline: previous generations had to be persuaded that ICT was a viable or exciting career path, whereas for Gen Alpha, entering ICT is less a deliberate crossing-over and more a continuation of lived experience (Ziatdinov & Cilliers, 2021). Their daily lives are closely connected to technology for entertainment, connecting with peers, and education. They are often described as the "creators, consumers, and decomposers" of modern machines Growing up with readily available digital solutions may contribute to an expectation that technology can help address everyday challenges, which may naturally support an interest in ICT roles centred on innovation and problem-solving (Astapenko et al., 2021). This early familiarity may support confidence and interest in ICT-related activities, although digital exposure does not automatically translate into professional ICT skills.

Learning and Training Preferences

Technology and play are intrinsically fused for this cohort - gamification is not an add-on incentive but a native mode of engagement (Tootell, Freeman & Freeman, 2014). This suggests Gen Alpha's motivational entry point into ICT is best characterised as playful/intrinsic engagement embedded in the learning tool itself, rather than mediated primarily through social or peer channels (Tootell, Freeman & Freeman, 2014). A systematic literature review notes a marked increase in STEM/ICT-oriented curricula aimed at this cohort, based on the assumption that their natural digital fluency can be leveraged early (Discover Education, 2024). One dissertation cited in that review found that a robotics curriculum increased elementary students' attitude, interest, persistence, self-efficacy, and career interest in STEM, with girls in the treatment group showing a specific increase in self-efficacy and career interest relative to girls in the control group, one of the few data points speaking directly to gendered motivation formation in this cohort.

Career and Employment Values

As the closest available evidence to actual "joining the sector" motivation, workplace-expectations research on young Gen Alpha employees in Poland found they place strong importance on employers' corporate sustainability practices (economic, social, and ecological) and on ICT implementation in the workplace, with economic security emerging as their top priority even as sustainability and technology expectations remain closely linked (Wojtaszczyk et al., 2025, Sustainable Development).

A companion study examining "Zalpha" (Gen Z/Alpha) workplace expectations more broadly found their priorities centre on fair pay, well-being, and a sense of agency, with employer-supported work–life balance mediating how job characteristics translate into positive outcomes (Syper-Jędrzejak et al., 2026, PLOS One).

As they grow, Gen Alpha is also expected to show a strong need for achievement, autonomy, and recognition which are often described as highly compatible with the competitive, innovation-driven nature of the ICT sector, alongside risk-taking behaviour, competitiveness, and a predicted unconventional creativity seen as essential for software development, AI, and digital design

A further ecological factor is the unparalleled number of employed women and mothers in this generation's environment: growing up in dual-career families where mothers are active in the workforce provides immediate role models for professional ambition, reinforced by a broader shift toward remote/tele-work that blurs the boundaries between personal and professional (Astapenko et al., 2021).

Set against these motivating factors, this cohort may also face specific inhibitors: digital risks such as cyberbullying and exposure to unwelcome content that could affect professional confidence, and a susceptibility to impaired social and emotional well-being linked to technology addiction and "robotic moments" of feeling more connected to devices than to people (Astapenko et al., 2021).

The most relevant Generation Alpha characteristics for the analysis of women in ICT are therefore:

- Early exposure to digital technologies (including AI)
- Interactive and play-based learning preferences
- Early, hands-on STEM/robotics interventions as a confidence builder

- Creativity, autonomy, and problem-solving orientation
- Greater visibility of female role models Relative wealth and easy access to devices/gadgets
- Need to address digital risks Preference for meaningful and flexible work

However, the potential inhibitors such as cyberbullying, exposure to unwelcome content, and technology-linked emotional/social well-being concerns, may undermine professional confidence and should be weighed alongside the positive motivational factors.

Given the cohort's youth, these characteristics are drawn largely from educational and early workplace-expectation studies rather than retrospective career-motivation research, unlike the other four generations. In further research phase we will target the Generation Alpha representatives: parents, teachers, caregivers.

Conclusion

A cross-generational comparison observes a broader trajectory in what “motivates engagement” with technology - shifting from authority/expertise (Baby Boomers) → practical application (Gen X) → peer experience and empowerment (Gen Y) → inspiration and co-creation (Gen Z). This maps onto a shift from extrinsic/controlled motivation toward more autonomous, intrinsically oriented motivation, consistent with Ryan and Deci’s (2000) self-determination theory framing.

3. Theoretical framework for understanding motivation towards ICT

Grounding the report in theoretical frameworks is essential because it moves the analysis from description to explanation. The generational chapter highlights the main differences and characteristics across cohorts. Theoretical frameworks such as Self-Determination Theory, Eccles' Expectancy-Value Model, Social Cognitive Career Theory and Science Capital help explain the psychological mechanisms behind these differences, including competence, autonomy, value and belonging. These frameworks also prevent generational traits from being interpreted as fixed characteristics. Instead, cohort differences can be understood as different expressions of similar underlying needs, shaped by each generation's technological and sociocultural context.

Motivation can be defined as the psychological force that drives, directs, and sustains intentional behaviour toward a goal (Hattie et al., 2020). It is not a single trait but a dynamic process shaped by an individual's beliefs about their own ability and by the value they attach to a given activity or career path (Eccles & Wigfield, 2002; Bandura, 1997). Self-efficacy in particular determines whether a person takes up a given type of work, how they perform in it, and how long they persist within it (Betz, Hammond, & Multon, 2005).

Understanding motivation is essential to closing the gender gap in ICT because women's underrepresentation in the sector cannot be explained by ability or opportunity alone, particularly given that girls often perform as well as or better than boys in related subjects. This indicates that the barrier to entry is substantially psychological and sociocultural rather than a matter of skill. A motivational lens allows this report to move beyond describing the gap and toward explaining why it persists: by examining how women come to believe ICT is, or is not, a field they can succeed in, a field that reflects their values, and a field in which they belong.

This motivational focus also provides the conceptual bridge between the generational cohort analysis in the previous chapter and the cross-country literature review of motivations, barriers, and policy that follows. Each generation was shown to relate differently to technology, learning, and career values: from the Baby Boomers' reliance on formal expertise, through Generation X's practical adoption of early computing and Generation Y's peer- and empowerment-driven engagement, to Generation Z and Generation Alpha's participatory, ambient, and gamified relationship with technology. Motivation for ICT can be seen to have shifted historically from controlled, externally regulated engagement rooted in authority and formal training toward increasingly autonomous, intrinsically oriented engagement rooted in self-direction, peer connection, and play (Ryan & Deci, 2020). The theories introduced below make it possible to interpret these generational differences not merely as descriptive trends, but as different configurations of the same underlying motivational mechanisms: competence, autonomy, value, and belonging.

Self-Determination Theory (SDT)

Self-determination theory holds that individuals develop autonomous, self-sustaining motivation when three basic psychological needs are satisfied: competence, the sense of mastery and capacity to succeed and grow, supported by well-structured environments offering optimal challenge and positive feedback; autonomy, the sense of initiative and ownership over one's own actions, which is undermined by external pressure but reinforced when ICT is pursued out of personal interest or value rather than external mandate; and relatedness, the sense of belonging and connection, which is especially consequential for women in ICT, where feeling respected and cared for within the learning or professional community supports motivation and wellbeing, while the thwarting of this need is damaging to both (Ryan & Deci, 2000).

Motivation to pursue an ICT career often shifts from extrinsic to autonomous forms through internalisation: a woman may not find every technical task inherently enjoyable, yet still pursue the field because she personally endorses its value or because it aligns with her core identity, and this internalisation is associated with a stronger, longer-term identification of oneself as a technical professional.

Because intrinsic motivation for school-related activities tends to decline over time, sustaining motivation in ICT requires need-supportive environments across the entire pipeline, from primary school through advanced career stages, rather than a single intervention point; autonomy-supportive mentors who acknowledge a student's perspective and offer genuine choice have been shown to predict the specific fields students go on to select. SDT also explains why gamified, participatory technology tends to be more motivating: the pull of such tools depends directly on how well they satisfy needs for autonomy, competence, and relatedness.

Eccles' Expectancy-Value Model

Expectancy-value theory holds that career motivation is shaped jointly by an individual's expectation of success and the value they attach to a given path. Girls often report lower self-efficacy in mathematics than boys even when their actual grades are equal or superior, and because ICT is widely perceived as math-intensive, this lower ability self-concept can lead capable girls to opt out of the field. A further barrier specific to ICT is its perception as an object-oriented, socially isolated field: women more often prefer people-oriented, communal careers that allow them to help others, whereas men may be drawn to agentic goals such as mastery over tools; when ICT is reframed as communal or societally beneficial, female interest increases measurably. Lifestyle values also weigh heavily, as women frequently prioritise work–family balance, and ICT is often perceived as incompatible with family responsibilities given its fast pace, long hours, and the difficulty of returning from maternity leave without falling behind on rapidly evolving technical expertise. An important and often overlooked finding is that mathematically capable women are more likely than equally capable men to also possess high verbal ability; this dual-ability profile broadens their range of viable careers, meaning able women may choose ambitious paths in law, the humanities, or medicine over ICT simply because they have the flexibility to weigh multiple options, not because they lack technical aptitude (Wang et al., 2013).

Family socialisation and school environments reinforce these patterns: parents often provide fewer math- and science-related opportunities to daughters and attribute their successes to hard work rather than innate ability, while teachers may unconsciously treat mathematics as a male domain, and broader stereotype threat - the fear of confirming a negative stereotype - can impair performance and cause women to disidentify with the field to protect their self-esteem.

Women's motivation to enter computing and technical fields is primarily driven by the subjective value they attach to these domains rather than differences in confidence or expectations of success. This motivation is heavily shaped by a collective gender identity that promotes a "person-orientation"—valuing work that involves understanding human interaction and directly helping people—which frequently conflicts with the cultural perception of technology careers as being "thing-oriented" and socially detached. Furthermore, early gender-role socialisation by parents and teachers often undermines girls' affinity for technology, as adults frequently underestimate girls' mathematical talent and actively provide boys with more early opportunities to engage in computing. Finally, because women are statistically more likely to value competence in multiple life roles simultaneously (such as career, parenting, and community), they perceive a significantly higher psychological cost in terms of the time and energy lost to a highly demanding, single-minded technology career (Eccles, 2009).

The examined literature points to clear intervention pathways: reframing ICT around its communal and societal benefits, providing early exposure to female role models, encouraging a growth mindset that frames technical skill as developed through effort rather than innate gift, and addressing structural barriers such as inflexible career tracks or inadequate childbearing accommodations. For women from lower socio-economic backgrounds, emphasising the financial security and high pay associated with ICT qualifications can be a particularly powerful motivator.

Social Cognitive Career Theory (SCCT)

SCCT identifies three variables that drive career-related behaviour: self-efficacy beliefs, or an individual's beliefs about their capability to perform specific technical tasks; outcome expectations, or beliefs about the consequences of a given career path; and personal goals, the intentions to engage in a particular activity, such as majoring in computer science. A woman is more likely to pursue ICT if she believes she can perform its tasks successfully and if she anticipates valued, positive outcomes such as tangible rewards, social approval, or attractive working conditions.

Interests are not innate but develop as an outgrowth of self-efficacy and outcome expectations, shaped by childhood and adolescent exposure to activities and the reinforcement received for engaging in them; motivation for ICT may therefore be lower among women where cultural norms have historically reinforced girls for different activities than boys. Self-efficacy itself is built through personal accomplishment, vicarious experience (observing “similar others” succeed) and social persuasion, making visible role models and direct encouragement critical to fostering genuine interest.

Even where a woman has clear talent for ICT, her environment must provide the conditions necessary for that interest to translate into action: choice goals are more likely to be pursued when supported by significant others and adequate resources, and in their absence women may compromise their interest in the face of family pressure, economic need, or lack of educational support, with pragmatic considerations sometimes overriding genuine interest. Where such supports exist, success in ICT tasks reinforces self-efficacy in a positive feedback loop that strengthens both interest and persistence through obstacles. A complementary social constructionist perspective adds that the categories of "ICT" and "gender roles" are themselves shaped by discourse and relationships rather than fixed facts, meaning women's motivation to enter the field can be understood as shaped by the prevailing cultural narratives of a given time and place (Hackett & Betz, 1981; Hackett & Byars, 1996).

Science Capital Framework

Science capital refers to the cultural, social, and economic resources related to science including scientific literacy, science-related dispositions, and social networks such as knowing people in science-related roles that shape whether a young person feels science, and by extension ICT, is "for me." Being knowledgeable about and positively predisposed toward information technology can itself be considered a form of capital conferring social and educational advantage, with informal practices such as programming contributing directly to a student's overall science capital. This capital is unevenly distributed by gender: boys tend to score significantly higher on average, while girls are over-represented in the low-science-capital group, a position associated with reduced interest in pursuing science-related careers.

A central barrier to women's motivation within this framework is science identity, which requires both self-identification and recognition by others as a "science person"; girls with low science capital often lack confidence in their abilities and sense that others do not perceive them as scientific, discouraging them from considering ICT as a viable path even when their attainment is high, in part because girls' successes are more often explained away as the product of hard work while boys' are attributed to natural talent. Motivation is further shaped by symbolic knowledge about the transferability of ICT qualifications in the labour market: students who understand that such qualifications lead to diverse careers are more likely to aspire to them, though this knowledge remains unevenly accessible to under-represented groups (Archer et al., 2015).

Conclusion

None of the mechanisms described above operate on gender alone. An intersectional lens attentive to the combined effects of gender, class, geography, disability, and migration background is necessary to avoid treating "women" as a homogeneous category within any of these frameworks, since the same mechanisms of self-efficacy, science capital, and need satisfaction are likely to operate with differing severity depending on a woman's broader social position. This lens is applied throughout the cross-country literature review that follows, in which motivational patterns are examined alongside structural barriers and policy responses specific to each partner country.

Although self-determination theory, the expectancy-value model, social cognitive career theory, and the science capital framework originate from different traditions, they converge on a small set of shared mechanisms relevant to women's motivation in ICT: a belief in one's own competence, a sense that the field is personally and socially valuable, a sense of autonomy and genuine choice rather than external or stereotype-driven pressure, and a sense of belonging within the ICT community. Read together with the generational analysis in Chapter 2, this integrated framework suggests that each generation of women has faced a different configuration of these same mechanisms, shaped by the technological, educational, and sociocultural conditions of its formative years, rather than facing entirely distinct motivational phenomena providing the analytical foundation for the chapter that follows, which examines how generational motivation, barriers, and policy responses to the ICT gender gap have played out empirically across the partner countries under review.

4. Five Generations: Motivations, Barriers, Policy and National Context across partners countries

To support a comparative understanding of women's participation in ICT across generations, each project partner reviewed the existing literature for the five generational cohorts covered by the research. The review focused on four key areas: motivational factors, barriers and challenges, national context, and common themes & evolving trends.

The aim was to examine how women's decisions to pursue ICT education and careers are shaped by both generational experiences and the wider national ecosystem, building on the findings of WP2, which focused on identifying the key factors and actors influencing girls' aspirations to pursue ICT studies and careers, as well as reviewing existing initiatives aimed at improving gender balance in ICT education and professions.

By comparing evidence across the seven European partner countries (Belgium, Croatia, Finland, Germany, Ireland, Italy, Sweden), the analysis identifies shared patterns, country-specific differences, and changes in motivations and barriers over time. Overall, in database 70 resources were analysed.

The availability of literature varied across generations for motivations, barriers and national context analysis, resulting in some variation in the depth of evidence available across cohorts.

General Motivational Factors

The literature identifies a broad range of factors that can influence women's participation in ICT and related technical fields. These factors combine socioeconomic opportunities, personal aspirations, family influence, and institutional support.

Key motivational drivers include:

- **Economic security and career prospects:** Higher salaries, better employment opportunities, and the potential for upward social mobility can make ICT and engineering careers attractive to women.
- **Family encouragement:** Support from close family members, including fathers, brothers, and husbands, can influence women's decisions to pursue technical studies and careers by providing encouragement, recognition of their abilities, and practical or emotional support.
- **Personal growth and vocation:** Internal motivation, personal values, interest in innovation, and a sense of purpose can encourage women to enter and remain in technical fields.
- **Challenging gender stereotypes:** For some women, entering a male-dominated field is also a way to challenge traditional expectations and demonstrate their capabilities.

The literature also highlights several support structures that can strengthen motivation and persistence:

- **Role models and mentoring:** Visible women in technical and leadership positions can inspire others and strengthen confidence and professional identity.

- **Inclusive educational and workplace environments:** Institutions that actively support diversity and address sexist behaviour can increase women's sense of belonging.
- **Support for work–life balance:** Guidance and institutional support can help women manage the interaction between education or employment and domestic or caregiving responsibilities.

These factors provide a general framework for understanding women's motivation to pursue ICT. However, the purpose of this chapter is to examine how these motivations and support needs differ across generations and national contexts. The following sections therefore explore which factors are particularly relevant to each generational cohort, which barriers remain persistent, and how these patterns have evolved over time across the seven partner countries.

4.1 Baby Boomers (1946–1964)

4.1.1 Motivational factors documented in the literature

The literature suggests that Baby Boomer women's engagement with ICT has often been driven by a combination of **competence, practical usefulness, employment considerations and personal autonomy**.

A recurring factor is perceived competence. Women who feel more capable of using technology tend to report greater confidence, interest and willingness to engage with digital tools. Previous professional experience and positive earlier encounters with media and technology can further strengthen familiarity and confidence.

For Baby Boomers generation, motivation is also strongly connected to the practical value of technology. ICT can support communication with family and friends, access to information and services, online banking and shopping, personal safety and greater independence in everyday life. The COVID-19 pandemic reinforced these motivations by increasing reliance on digital technologies for maintaining social relationships and everyday routines.

For Baby Boomer women entering engineering and technology, motivations were particularly connected to labour-market demand, stable employment, professional prestige and career prospects (Mursu et al., 2015). Compared with later generations, career choices appear to have been more strongly influenced by economic security and labour-market structures than by identity or personal fulfilment.

In employment and career contexts, recurring motivators include:

- financial rewards and job security;
- career development and advancement;
- independence and flexibility;
- meaningful work and intellectual challenge;
- continuous learning and reskilling;
- opportunities to use previous professional experience;
- work–life balance;
- supportive colleagues, family and peers;

- inclusive organisational cultures and visible female role models.

Some literature also identifies technology as a means of **social and political empowerment**, including women's participation in digital activism, feminist networking and cyberfeminist movements.

Overall, the evidence suggests a gradual movement from **employment security and economic necessity towards autonomy, flexibility, meaningful work, lifelong learning and continued participation** as women moved through later career stages.

4.1.2 Barriers and challenges documented in the literature

For Baby Boomer women, barriers to participation in what is now understood as ICT need to be considered within the technological context of their formative years. Computing, telecommunications and related technical fields already existed, but they were not yet integrated under the broadly defined ICT sector recognised today. It was not until 1998 that OECD countries agreed on the first internationally harmonised, industry-based definition of the ICT sector.

The most consistent barriers concern **gendered socialisation, confidence, limited early exposure to technology and male-dominated educational and workplace environments**.

Women in the Baby Boomer cohort frequently report lower levels of technology-related confidence, perceived competence, control, and interest than men, even when their actual levels of technology use are similar. This suggests that gender differences are more pronounced in perceptions and attitudes towards technology than in technology use itself.

Limited exposure to computers and ICT during childhood and early adulthood is particularly relevant for Baby Boomers. Many encountered digital technologies only after entering the workforce, which could contribute to:

- lower confidence in learning new technologies;
- fear of making mistakes or being unable to learn;
- dependence on relatives or other "proxy users";
- privacy and security concerns;
- limited digital and media literacy.

Gendered barriers also extend beyond digital skills. Technology has historically been presented as a masculine field, and women entering ICT or engineering frequently encountered stereotypes about women's technical competence and belonging.

Workplace barriers identified across the literature include:

- masculine organisational cultures;
- gender bias in recruitment and promotion;
- unequal pay and limited access to leadership;
- male-dominated professional networks;
- subtle workplace exclusion;

- lack of female role models;
- insufficient equality measures and monitoring.

For Baby Boomer women in particular, **care responsibilities and career interruptions** represented significant structural barriers. Expectations around childcare, elder care and household responsibilities could restrict working hours, professional development and continuous labour-market participation.

Women from this generational cohort may additionally experience **intersectional discrimination based on both gender and age**, including ageism, sexism and assumptions that older workers are less technologically capable. Self-doubt, imposter syndrome, limited access to reskilling opportunities and the absence of structured return-to-work pathways can further reinforce exclusion.

Overall, the barriers appear to operate across the entire life course: **limited early exposure → reduced confidence → restricted entry opportunities → workplace inequalities → difficulties with reskilling and continued participation later in life**.

4.1.3 Policy and national context across countries

National policies, labour-market structures and social norms provide an important context for understanding women's motivation to enter and remain in ICT. Evidence from Belgium, Croatia, Finland, Germany, Ireland, Italy and Sweden shows that generational experiences cannot be examined independently of the national environments in which women grew up, studied and worked.

A recurring finding from WP2 Transnational report highlights the distinction between **formal equality frameworks and their practical implementation**. Gender-equality legislation and national strategies exist across the countries examined, but their impact depends on adequate funding, long-term programmes, educational investment, employer incentives, monitoring and organisational accountability. Without these mechanisms, formal commitments to gender equality may have limited influence on women's actual opportunities to enter and progress within ICT.

National differences are important when interpreting generational patterns. As Baby Boomer-specific evidence is uneven across the seven countries, the overview below presents the most relevant available national findings. For Austria/Germany and Italy, available Baby Boomer-specific literature addresses general digital inclusion and technology use rather than ICT education or career participation directly. This evidence is included as indirect support for the exposure–confidence barrier chain, but represents a thinner evidentiary base than the labour-market-focused literature available for Belgium, Finland and Croatia:

For Austria and Germany, the research on women aged 60–70 in Styria highlights the importance of both generational media socialisation and individual life-course experiences (Ratzenböck, 2016)**.** Digital inclusion among older women therefore depends not simply on age, but on previous educational, professional and personal exposure to technology.

Digitalisation has progressed, but gender differences in the psychological determinants of technology use remain a persistent digital gender divide despite greater overall access (adults 60+) in German context (Ferizaj et al., 2024).

For Italy, research among adults aged 65+ highlights comparatively limited internet use among older people, particularly those aged over 75. The Italian literature places particular emphasis on digital and media literacy as a lifelong educational need and refers to the European DigComp framework as a relevant reference point (Carenzio et al., 2021).

For Croatia, the context combines labour-market and cultural dimensions. Studies of multigenerational workplaces emphasise work–family balance and employment motivation, while Croatia also developed early forms of cyberfeminist digital participation through initiatives such as *Zamir/women* and *Elektroničke vještice* (Dobrotić & Laklija, 2009). This indicates that digital technologies could function both as workplace tools and as spaces for women's activism and empowerment.

Finland presents a comparatively strong labour-market demand for ICT professionals, but persistent gender segregation remains. Flexible pathways such as open university education, MOOCs and adult education funding have supported reskilling, although restrictions within higher education and unequal access to adult-learning support have created barriers (Terho, 2025).

Finland also has a strong gender-equality framework, including organisational equality plans and pay audits. However, implementation remains uneven, and assumptions of gender neutrality may obscure persistent inequalities in recruitment, promotion and the male-dominated STEM pipeline (Bairoh, 2020).

The Irish context places greater emphasis on workforce reskilling, lifelong learning and responding to shortages of ICT professionals (Williams et al., 2025). This creates opportunities for later career transitions and continued skills development, although the available evidence provides limited Baby Boomer-specific analysis.

The Belgian context was particularly shaped by traditional labour-market and gender arrangements during Baby Boomer women's prime working years. Early computing and data-processing jobs sometimes employed significant numbers of women, but the professionalisation of computer science and expansion of higher-status technical roles increasingly favoured men. ICT is presented as a key symbol of workplace modernisation and of broader changes such as outsourcing, automation and network-based organisations. For workers aged over 50, ICT represents a significant transformation, as much of their working lives developed before its widespread use, and difficulties with technology may be associated with feelings of stagnation or reluctance to change. By contrast, younger generations tend to integrate ICT more naturally into everyday life and leisure and often possess stronger technological skills. Generational differences also appear in organisational values, with older workers more oriented towards communitarian, collective and family-like workplace structures, while younger workers are more closely associated with liberal and open organisational models (SPReW Project Consortium, Deliverable 3, 2008).

More recent Belgian initiatives aimed at women's digital participation and reskilling reflect attempts to address this long-standing imbalance, but the historical context helps explain why many women of this generation had comparatively limited opportunities to enter or progress within ICT.

Traditional single-earner household expectations, tax structures and family responsibilities also made continuous career progression more difficult for women. Formal equality legislation and broader workplace reforms developed relatively late in many Baby Boomer women's careers.

An interesting note on the historical origins of the masculine-coding barrier (US context): The perception of technology as a masculine field, documented consistently across all five generations in this report, is not a timeless given but can be traced to a specific historical turning point. Prior to 1984, women earned nearly 37% of computer science degrees in the United States, when programming was culturally associated more closely with detail-oriented "feminine" work. The shift coincided with the rise of the personal computer, which was marketed heavily towards boys, creating an early-exposure gap. As the field gained prestige and higher salaries, "hacker" and later "brogrammer" cultures emerged alongside hiring bias, wage gaps and workplace exclusion, reinforcing the masculine organisational culture and early-exposure barriers traced across subsequent generations in this report. This history supports the report's central argument that gender imbalance in technology is historically contingent rather than inevitable, shaped by marketing, culture and institutional practices rather than ability (CEPIS, 2025).

Across countries, **competence, employment security, autonomy and practical usefulness emerge as the most consistent motivational factors, while gender stereotypes, limited early exposure, care responsibilities and male-dominated structures remain the most persistent barriers**.

4.1.4 Common Themes and Evolving Trends

Motivation is increasingly seen as hybrid: generation-specific but also shared across cohorts. Strong individual agency, the central role of identity construction, social embeddedness of career change, and the importance of life stage and values emerge alongside the coexistence of structural barriers and flexible opportunities, and gender as a contextual but not dominant factor.

Career motivation cannot be separated from unpaid care work and gendered family expectations. Gender differences lie mainly in attitudes and competence beliefs rather than actual use. Technology competence is the central factor linking acceptance, interest, and use, especially relevant for explaining lower engagement among women. Findings emphasize psychosocial mechanisms (self-efficacy, stereotypes) and the need for gender-sensitive digital inclusion interventions.

A strong tension between meritocracy beliefs and persistent inequality also emerges, with masculine organisational culture as the central barrier, a gap between equality values and practical implementation, systematic questioning of women's competence, the structural nature of career inequalities, and the importance of organisational practices (recruitment, promotion, leadership).

The Croatian context for Baby Boomer cohort shows ICT as a space of feminist resistance, not only labour-market participation (Janković, 2009).

ICT use among older women is a dynamic, lifelong process shaped by the interaction of generational experiences and individual biographies. Early-life experiences have long-lasting effects, but later-life interests and experiences also influence technology engagement. The study challenges stereotypes of older women as passive technology users and highlights diversity within older generations of women.

Evolving trends show a shift from "equality already achieved" to recognition of hidden structural inequality and a move from individual explanations to structural analysis. There is an increasing focus on organisational processes and recruitment pipelines, growing emphasis on monitoring and data (but weak implementation), a shift from access to retention and career progression issues, recognition that cultural change is essential alongside numerical targets, and increasing attention to role models and representation.

At the same time, there is a shift to non-linear career paths, emphasis on identity and meaning over ability, increasing importance of flexibility and lifelong learning, gradual cultural inclusion in ICT, stronger focus on work-life balance and authenticity, and growing individual responsibility for career transitions.

These trends move toward a more nuanced, intersectional understanding of discrimination, integrating age, gender, and organizational climate. Increasing use of career-change pathways to address gender gaps in ICT also positions mature women as an untapped talent pool.

4.2 Generation X (1965–1979)

4.2.1 Motivational factors documented in the literature

Pedagogical and collaborative learning factors. Bottom-up, collaborative learning approaches (CSCL) are documented as supporting awareness of gender bias and improving inclusion within STEM learning environments. Counter-stereotypical role assignment in group work is shown to positively influence perceptions of women's competence and leadership potential, and pedagogical interventions that explicitly address gender bias are identified as a mechanism for creating more equitable classroom experiences. This motivational factor is more strongly associated with Generation X than with the Baby Boomer cohort, suggesting that potential interventions may begin earlier through educational design, rather than relying solely on workplace policies.

Interest and career prospects. Career interest and prospects continue to appear as a motivator, consistent with the Boomer-cohort pattern, though without yet the same explicit "labour-market rationality".

Career growth and inclusive environments. Motivators include career growth opportunities, mentoring, female role models, recognition of women's achievements, equal opportunities, inclusive groups and events, and flexible work arrangements with stronger work-life balance support. Participants also emphasise the importance of visible women in technical and leadership roles as a driver of confidence, belonging, and retention.

Professional identity. Motivations for Generation X increasingly foreground **professional identity** as a distinct driver. Engineering careers are associated not only with economic stability (as with the Boomer cohort) but with expectations about the nature of the professional role itself. Individuals were required to align personal values with the perceived identity of "being an engineer," making identity formation a central component of career progression (Naukkarinen & Bairoh, 2022). **This marks a first visible generational shift from the Boomer pattern: where Boomer motivation was framed primarily around stability and prestige, Gen X motivation begins to visibly incorporate identity alignment alongside stability.**

4.2.2 Barriers and challenges documented in the literature

The following barriers were identified through the literature review extraction matrix and the literature analysed by project partners:

Gender bias in STEM higher education. Strong gender bias persists throughout STEM higher education: stereotypes about women's competence, heteronomous gender roles, sexism, unequal workload distribution, and structural power imbalances. Women in STEM report discrimination in academic settings, including being undervalued in leadership and collaborative work with persistent stereotypes shaping both participation and confidence.

Early-formed stereotypes and educational barriers. Gender stereotypes form early and influence subject/career choices; lack of encouragement and guidance toward ICT; strong gender segregation persists in education; discrimination and bias, male-dominated culture, and minority status are common experiences; self-doubt and stereotype threat, gendered expectations in group work, work-life balance concerns, and lack of information about ICT pathways all compound the effect.

Reasons for reconsidering career choice. A distinct gendered pattern emerges here: women more often reconsider their field choice or feel engineering was not the right initial decision, whereas men more often cite salary dissatisfaction or a poor job market as their reason for reconsidering i.e. the *locus* of doubt differs by gender, not just its frequency.

Workplace and retention barriers. Work-life balance strain, pressure to work extra hours, lack of parental support, sexism, lack of recognition and peer parity, impostor syndrome, glass-ceiling effects, "prove-it-again" bias, and maternal-wall dynamics. Factors pushing women to leave the field include limited career growth, pay inequality, lack of flexibility, maternity-related penalties, hostile sexism, and insufficient well-being support.

Cultural and identity-based tensions. For Generation X, barriers are described as **less overtly structural and more closely tied to cultural and identity-based tensions**. Engineering culture continued to privilege technical competence and masculine norms, creating friction for women whose interests extended into social or communicative dimensions of the work. This mismatch reduced career-fit confidence and increased exit risk (Naukkarinen & Bairoh, 2022). Gender disparities in career outcomes such as less stable employment, fewer advancement opportunities, became apparent early in the career, rather than only accumulating over decades.

4.2.3 Policy and national context across countries

Rather than a uniform national picture, the evidence for Generation X points to several recurring structural themes: the role of institutional and educational contexts, the gap between formal equality frameworks and their practical effect, and the limits of corporate diversity commitments. The following section provides a selected overview of these patterns. It is intended as an illustrative summary rather than a comprehensive country-by-country analysis, reflecting the limited availability of relevant literature across all countries.

Institutional and educational contexts

The study analysed from **Germany** (Kube et al., 2024) is based on a Group Concept Mapping (GCM) approach with 70 female professors, teaching staff, and scientific staff from German STEM universities. Participants identified and ranked gender bias experiences and evaluated potential pedagogical interventions, particularly in computer-supported collaborative learning (CSCL) environments. Findings highlight the relevance of institutional contexts in German higher education and link to broader literature on gender inequality in STEM academia. The study emphasizes bottom-up pedagogical strategies complementing top-down equality policies.

Finnish education system characterised by strong gender segregation; school system and guidance practices shape career choices; limited exposure to ICT (e.g. coding) in earlier education; presence of equality and non-discrimination legislation; persistence of gender equality paradox (high equality but strong segregation); need for structural interventions such as role models, targeted outreach, and gender-sensitive pedagogy (Toivonen & Savimäki, 2021).

Equality legislation versus practical impact

Strong equality framework in Finnish context, but limited effect on engineering gender gap. The expansion of Nordic welfare policies during this period significantly improved institutional support for gender equality. However, these reforms did not eliminate occupational segregation. Despite formal equality measures, engineering remained male-dominated, indicating that structural equality alone cannot address deeply embedded cultural norms (Bairoh & Naukkarinen, 2025).

What differentiates Generation X

Formal equality frameworks and legislation can coexist with strong occupational segregation: a “gender equality paradox” in which high overall equality does not translate into gender balance in engineering.

Structural and legislative equality measures alone do not address deeply embedded cultural norms, whether at the level of the welfare state or within a multinational corporation with its own diversity targets. Corporate diversity goals can exist independently of national policy, showing that organisational commitments and national frameworks operate on separate tracks.

4.2.4 Common themes and evolving trends

Gen X evidence base converges on gender bias as **multidimensional rather than singular**: stereotypes, structural inequality, and cultural norms are perceived by experts as interconnected, reinforcing the finding that institutional/pedagogical and legislative/policy levers must work together, since neither alone addresses the full picture. Computer-Supported Collaborative Learning-based interventions (role design, collaborative scripts, socio-cognitive conflict) are highlighted as a promising, concrete pedagogical lever - the clearest actionable mechanism the Gen X literature offers, and one with no direct Boomer-cohort equivalent, since Boomer interventions in this report are framed almost entirely at the workplace/policy level rather than the classroom level.

Beyond higher education specifically, common Gen X themes include: the strong role of mathematical ability and self-concept; the importance of family, teachers, and social environment; the significance of female role models; persistent gender stereotypes shaping interests and choices; structural gender segregation in education; mixed experiences in male-dominated environments (both inclusion *and* bias reported); and the central role of the school system itself in shaping career pathways.

An **industry perspective, from attraction to retention,** adds a distinct workplace-level theme: even companies committed to diversity and inclusion show persistent socio-cultural barriers, meaning stated commitment does not equal practical retention. Suggested mitigations include sabbatical policies, flexible time/location arrangements, parenthood support, soft-skills training for managers, equal pay and opportunity, mentoring, active hiring of women, women's support groups, public recognition, and visible success stories. This directly echoes the "shift from access to retention" trend already flagged for the Boomer cohort, confirming it as a genuine cross-generational pattern.

Evolving Trends

The Gen X evidence documents a clear directional shift: from external influence to individual agency in career choice; from ability-based explanations to confidence and identity factors; increasing recognition of subtle (rather than only overt) discrimination; a shift from access issues toward experience and retention in ICT; growing emphasis on gender-aware, not merely gender-neutral, interventions; a focus on early educational intervention; reframing barriers as a lack of awareness/information rather than only structural exclusion; and growing recognition of multiple, non-linear pathways into ICT.

Generation X marks a transition from structural barriers to identity-related challenges. While access to education improved, persistence became increasingly dependent on the ability to settle individual identity with professional expectations. This shift laid the foundation for later research emphasising cultural and psychological dimensions of gender inequality.

4.3 Millennials (1980–1994)

4.3.1 Motivational factors documented in the literature

Viewed against the two preceding cohorts, Millennial motivation marks a further step along the trajectory already visible from Boomers to Gen X. Whereas Boomer motivation centred on economic stability and labour-

market rationality, and Gen X motivation added professional identity alignment as a distinct driver, Millennials continue to prioritise career prospects. Employability, salary, and entrepreneurship potential remain among the most frequently cited drivers while meaningful work, societal impact, communication, ethics, and sustainability emerge as additional factors influencing career choice particularly for women in this cohort (Naukkarinen & Bairoh, 2022). This is the clearest new element the Millennial data contributes: motivation is no longer just stability (Boomers) or identity-fit (Gen X), but active alignment with personal values.

The most distinctive finding, with no real precedent in either earlier cohort, is **intergenerational resource transfer**: daughters exposed at home to technical skills, professional networks, or a mother working in a STEM or otherwise non-traditional occupation are markedly more likely to pursue technical fields themselves (Van der Vleuten et al., 2018). Mothers in masculine-coded occupations appear to function as a counterexample that makes gender-atypical choices feel more conceivable, while technically-employed fathers exert particular influence in higher-educated families, partly through status-maintenance and a rational-choice logic of avoiding downward social mobility. This is a genuinely new causal mechanism relative to Boomers (whose motivation was structural/economic) and Gen X (whose motivation centred on institutional and identity factors) – family-transmitted exposure operates earlier and more directly than either (Van der Vleuten et al., 2018).

Key motivators include high self-efficacy (belief in ability), positive outcome expectations (salary and growth), and access to visible female role models and mentors. Environmental factors such as work-life balance, flexible policies, inclusive organizational cultures, and early positive exposure to technology also significantly drive interest and persistence.

Early self-efficacy distinguishes this cohort. Belonging, self-efficacy, and identity now appear together as a positive motivational cluster, distinguishing this cohort from Gen X, where identity was documented primarily as a source of career-fit tension rather than a motivator.

Workplace-level evidence (KPMG, 2017) adds practical texture without repeating the above: this cohort explicitly seeks cultural fit, flexibility, open feedback, and purpose-driven employers, with a gender split in priorities_: women rank work-life balance and promotion above salary, men rank salary highest.

4.3.2 Barriers and challenges documented in the literature

Across the Millennial literature, the most persistent barrier is the **masculine coding of ICT, STEM and engineering**, which continues to shape women's educational choices, confidence and career progression. Socio-culturally, the dominant “geek and hooded gamer” stereotype makes ICT difficult for women to identify with, reinforced by media portrayals in film, television, and advertising. Broader societal sexism and the perception of ICT as a “things-oriented” rather than people-centred field further deter women, as does a narrow public image that reduces ICT to programming and gaming, obscuring broader aspects like design and social impact. Knowledge gaps compound this as many women lack accurate information about what ICT programmes actually involve. Internally, women report a confidence gap even when performing equally to male peers, and academic environments can be gender-conservative, with female teaching staff facing

implicit bias in course evaluations. Structurally, gendered recruitment patterns in industry persist beyond education, visible female role models are scarce, and interventions typically arrive too late. Information about ICT needs to reach girls at primary school level, before stereotypes solidify.

The HER TECH **Gender-Sensitive Engagement Framework** (available at: https://her-tech.eu/documents/), developed in Work Package 3, responds directly to this evidence base, translating it into a practical model for K-12 educators built around four interdependent pillars: Access (ensuring girls are structurally included in ICT through mandatory rather than elective participation, early exposure from ages 4–7, and removal of cost and timetabling barriers), Belonging (reframing computing as creative and socially meaningful rather than abstract and competitive, and honouring girls' tendency toward an "observer phase" before active participation), Recognition (making girls' technical competence visible through role rotation, proactive feedback, female role models, and public showcases), and Progression (sustaining engagement over years through scaffolded skill-building, peer mentoring, and explicit connections to diverse career pathways).

The framework argues that engagement is not accidental but must be deliberately designed, and that the four pillars reinforce one another - access without belonging produces disengagement, belonging without recognition produces invisibility, and recognition without progression produces lost potential. Notably, the framework's own evidence converges with the literature's central timing claim: **pre-primary and early primary school emerge as the critical window before stereotypes solidify, since a single well-designed intervention in adolescence cannot undo years of prior cumulative messaging about who technology is for.**

A closely related barrier is the **gender gap in confidence and technical self-concept**. Women consistently report lower self-efficacy in technical ability *despite performing at levels comparable to men*, a gap that emerges early, through gendered subject choices and unequal encouragement, and persists even among women already studying engineering or ICT. This lower confidence subsequently affects applications, persistence, willingness to pursue promotion, and expectations around leadership.

These effects extend across the full education-to-employment pathway: women are less likely to enter certain STEM fields and show higher attrition once in them. Limited role models, insufficient career information, and the absence of family-based technical exposure make it harder to imagine ICT as a realistic pathway. Interventions typically arrive too late, after these perceptions have already solidified, which is consistent with the Boomer-cohort finding that early exposure is the strongest single predictor of later confidence, arguably the single most useful cross-generational anchor point for a policy-facing report.

Within workplaces, women encounter male-dominated organisational cultures and unequal development opportunities: gendered job descriptions and biased selection at recruitment; exclusion from informal networks and limited mentorship after entry; repeated pressure to prove competence; assignment to less technical work; and reduced access to progression. **Tokenism and the assumption that women were hired mainly to meet diversity targets** further erode professional confidence and belonging. This is one of the more actionable findings, since it points to a specific, nameable organisational behaviour rather than a diffuse cultural attitude.

This sits alongside a **psychosocial and cultural mismatch between women's values and dominant engineering culture**, the same technical/social dualism first identified in the Gen X material, where technical competence carries more status than social or communicative skill, and the divide is itself gendered. What Gen X described as an identity tension, the Millennial evidence sharpens into something closer to a fixed set of workplace expectations: women report having to actively manage the gap between their professional and gender identities rather than simply feeling it as friction. **This shift from felt tension to managed performance is arguably the clearest generational escalation in the barriers data so far.**

Family responsibilities remain a major structural barrier in their own right: motherhood, childcare, and work-life balance pressures affect promotion applications, career continuity and retention, compounded by expectations of high availability and long hours. Gender and age can intersect to produce disadvantage at multiple career stages simultaneously.

Country-level evidence further reinforces these patterns. **In Sweden** (De Lara & Liu, 2016), despite strong national equality policies, a masculine culture around computers persists. Women report being "taken lightly" and underestimated by male peers, with some being told that they were hired only to fill a quota or having their work attributed to others. Gendered toys and parental biases can shape girls' perceptions of technology from an early age, steering them away from the field before they reach formal education. In academic and professional settings, women often face pressure to overperform in order to establish credibility, while pedagogical practices may inadvertently reinforce male dominance, for example through unequal teacher attention or placement in lower-ability groups. Persistent stereotype threat can erode self-efficacy, while the limited visibility of female role models makes it more difficult for girls and women to envision a long-term career in computer science. Women also report tension between their technical and feminine identities, with some feeling that fitting into the industry requires them to suppress aspects of themselves.

In **Finland**, the principal barriers for this generation stem from cultural and value misalignment. Engineering continues to be framed through a technical/social dualism, in which technical competence is prioritised while social and communicative dimensions are marginalised (Naukkarinen & Bairoh, 2025). This dualism is also gendered, associating sociality with femininity and technicality with masculinity (Naukkarinen & Bairoh, 2022). Such framing can disadvantage individuals who value broader and more socially oriented roles, contributing to lower persistence in the field.

Women are also more likely to emphasise communication skills, which are often associated with lower status within engineering. This imbalance can contribute to career divergence and increase the likelihood of leaving the field. Workplace cultures characterised by masculine norms and implicit bias further reinforce these challenges (Naukkarinen & Bairoh, 2022).

Overall, the Millennial evidence marks a shift from understanding underrepresentation primarily as a matter of individual skill or choice towards recognising a multi-level system of barriers spanning early socialisation, confidence, education, recruitment, organisational culture, career progression and family responsibility. These barriers do not operate in isolation; rather, they reinforce one another over time, affecting both women's

initial motivation to enter ICT and their willingness and ability to remain and advance within the field. This understanding of barriers as interlocking rather than merely additive provides an important basis for the Gen Z analysis and the final cross-generational synthesis.

4.3.3 Policy and national context across countries

The dominant theme, carried forward and deepened from Gen X, is the gap between formal equality policy and lived workplace outcomes: the equality paradox. Despite strong legislative frameworks, anti-discrimination measures, parental-leave policies, publicly funded education, and high levels of formal gender equality, women remain significantly underrepresented in ICT education and professions. Strong educational performance does not necessarily translate into equal participation, career stability, or advancement in the sector. Across contexts, this highlights a persistent disconnect between formal equality and women's actual educational and professional outcomes in ICT, with the same paradox continuing to emerge across successive generations.

National contexts show that women's participation in ICT is influenced by education systems, equality policies, access to STEM opportunities and the implementation of workplace measures. Across countries, a key issue is the persistence of gender imbalance despite existing initiatives and equality frameworks.

Croatia continues to have low female participation in ICT education and employment despite STEM scholarships and initiatives such as EU Code Week, Women in IT and ICT Supergirls (Dremel, 2023). Evidence from high-school students in Zagreb and Karlovac confirms that technical fields remain male-dominated (Jugović, 2010).

Germany highlights the importance of early technology education and school infrastructure. The study compares Germany and Austria and highlights differences in educational systems and technology education (Quaiser-Pohl & Endepohls-Ulpe, 2012**)**. In Austria, technology and crafts education is compulsory in primary school, while secondary students choose between technical and textile work. Austrian schools appeared more supportive of STEM overall, and Austrian students reported higher ICT self-concepts, potentially linked to better ICT infrastructure in schools. Compared with Austria, German schools (Stefani, 2024) were described as comparatively under-equipped with computers and digital resources. The evidence supports compulsory technology education and early interventions, particularly for girls. The study also focuses on STEM persistence in the German higher education and labor market context. Germany is characterized by relatively strong links between educational qualifications and labor market outcomes, making STEM dropout during labor market transition particularly noteworthy. The analysis is based on Starting Cohort 5 (SC5) of the German National Educational Panel Study (NEPS), including 17,910 students who entered higher education for the first time in the winter term of 2010. At higher education level, mentors, lecturers and institutional support programmes are important for STEM persistence and transitions into employment (Stefani, 2024).

Finland has increasingly promoted STEM participation, but grouping different disciplines under the broad STEM category can obscure challenges specific to engineering. Key policy concerns include:

- belonging as a policy issue (Bairoh & Naukkarinen, 2023)

- the need for broader representation of engineering roles
- gendered structures and cultural norms that persist: women have less stability and advancement, and more interruptions

Policy efforts during this period increasingly focused on STEM participation. However, the aggregation of diverse disciplines under the STEM umbrella obscures critical differences between engineering and other fields. As a result, policies aimed at increasing STEM participation do not necessarily address the specific challenges associated with engineering, limiting their effectiveness (Naukkarinen & Bairoh, 2020).

Italy highlights territorial inequalities in the digital gender gap, particularly in Southern Italy. The 2021 National Strategy for Gender Equality addresses five areas - work, income, skills, time and power - and is linked to Agenda 2030 Goal 5 on gender equality (Pirlo et al. 2023).

Sweden demonstrates a particularly strong contrast between formal equality and ICT participation. ICT is a primary economic driver in Sweden, accounting for six in ten new jobs between 2010 and 2016, yet the sector faces a growing digital skills shortage that gender imbalance worsens. Women represent 61% of higher education students overall but only 32% of ICT students nationally, reflecting a persistent national gendered pattern (Kurti et al., 2024). Sweden has strong equality policies framing educational inclusion as essential for fair income distribution and societal participation. Legislatively, Sweden has anti-discrimination laws, work environment regulations requiring employer accountability, and national parental leave and flexible work policies (Keshari, 2024). Higher education is publicly funded through tax revenue, and the CSN system provides grants and loans to ensure access regardless of family wealth. National policy also promotes dual responsibility, encouraging men to share equally in childcare while women enter the workforce (De Lara & Liu, 2016).

Despite this robust framework, Sweden's "gender-equality paradox" is notable: high levels of national equality and female academic achievement do not translate into ICT participation, with women outperforming men in primary education and graduation rates yet remaining underrepresented in technical fields. A key finding is the gap between formal policy and lived reality: company gender equality strategies frequently fail to translate into meaningful change for women in IT. CS remains heavily male-dominated: only around one-fifth of system designers and programmers are women. Researchers argue that counting students is insufficient - policy must also address gender-conservative pedagogical environments, gendered industry recruitment, and introduce ICT awareness at primary school level before stereotypes take hold. Sweden faces a projected shortage of at least 70,000 IT specialists by 2024, making gender inclusion a macroeconomic priority. Flexible and remote work policies are identified as essential retention tools for Gen Z. Organizational policies are necessary to prevent dissatisfaction but insufficient alone to drive motivation (Nygård & Västanälv, 2021).

Ireland addresses participation through the STEM Education Policy 2017–2026, the Work Life Balance Bill 2022 and initiatives promoting women in STEM, linking STEM participation with wider measures supporting employment and work–life balance. For Belgium, approaches such as primary and secondary school engagement, mentoring, work experience and teacher involvement aimed at increasing girls' exposure to technology careers are highlighted (O'Brien, 2022).

Overall, the national evidence indicates that policies supporting women's ICT participation are most relevant when they combine early technology exposure, education and mentoring, gender-equality measures, workplace support and opportunities for continued participation. At the same time, Croatia, Finland and particularly Sweden show that formal initiatives can coexist with persistent gender segregation in ICT - confirming the equality paradox as a recurring, cross-national structural feature of the field rather than an isolated case.

4.3.4 Common themes and evolving trends

Millennial evidence continues a trajectory visible since the Boomer cohort, reflecting a shift away from explaining underrepresentation through individual deficit and toward socio-cultural explanation, now increasingly grounded in qualitative, practitioner-level insight rather than survey-level attitude data alone. Gender stereotypes are understood not only as affecting perceived ability, but also as shaping perceptions of fit and usefulness, providing a more precise formulation than the Boomer-era "confidence gap" framing.

Early childhood is confirmed, again, as the key intervention point, with interest and self-efficacy developing during primary school. Cross-national evidence (Germany, Austria) shows the same stereotype mechanisms operating regardless of country, with school systems still struggling to counteract them. What is genuinely new here is a mechanism for how influence changes over time: parental and peer influence, strong through adolescence, measurably weakens after graduation, replaced by "weak ties" as the more relevant support at labour-market entry. Neither the Boomer nor Gen X material identified this kind of time-varying support structure; it is a more precise account of when different relationships matter, not just that relationships matter.

The identity-based explanation that began with Gen X and sharpened through the Millennial barriers section continues here as an explicit trend. Research increasingly explains the gender gap through value alignment, organisational culture, and career fit rather than capability alone. At the same time, the evidence suggests that this perspective remains difficult to realise in practice, as educational institutions and workplaces continue to privilege technical roles over social ones.

Two findings stand out as distinct contributions that are not evident in the earlier cohorts. First, post-Covid digital inclusion accelerated meaningfully for women in **Italian context** (online learning, digital services, remote tools), but the gap persists specifically in advanced digital skills, ICT employment, leadership and entrepreneurship (Pirlo et al., 2023). Second, trends among immigrant backgrounds: an evolving finding is that adolescents with non-western immigrant backgrounds often choose less gender-stereotypical fields (specifically business and law) than their western peers. This is suggested to be a strategy to compensate for lower socioeconomic status by pursuing more lucrative, gender-neutral fields (van der Vleuten et al., 2018).

Sweden contributes one finding worth flagging on its own terms: female ICT graduation rates were higher in the 1980s than they are today, indicating that the gender gap has not only persisted but, by this measure, has widened. Sweden's material (Kurti et al., 2024) also introduces the first mention of AI as a new dimension of urgency. The underrepresentation of women in ICT is explicitly linked to gender bias in AI systems and

algorithms, reframing women's participation as both a technical and an ethical necessity rather than solely an issue of fairness.

On retention specifically, the literature largely confirms the barriers already established (the availability dilemma, "princess passenger" protectionism, masculine norms) while adding a cautiously positive trend line: 2018–2023 data shows slow but real improvement, companies are adopting concrete diversity targets and gender-decoding hiring tools, and hybrid/flexible work is becoming a baseline expectation rather than a perk (Keshari, 2024). This extends the Gen X shift from access-to-retention and giving it multi-year directional data rather than a qualitative observation.

Finland's own framing of this cohort is the most concise summary available: for Millennials, the key issue is retention rather than entry, with identity-based, career-fit confidence now the central explanatory factor (Naukkarinen & Bairoh, 2021). This reflects a direct continuation of the "structural-to-identity" pivot already flagged at the Gen X stage, now stated as the defining feature of the Millennial experience specifically.

Overall, the evidence shows that women's participation in ICT and engineering is shaped by a long-term interaction between early educational experiences, gendered self-concept, institutional structures and workplace expectations. Career development should therefore be understood as a continuous process rather than a single decision, with schools and institutions providing sustained guidance, practical exposure and discipline-specific support from an early age. Gender stereotypes remain a central barrier, but they increasingly operate through subtle cultural cues that influence confidence, perceived usefulness, parental support and belonging, even when students do not consciously recognise their effect. These barriers are particularly concentrated in engineering and technology, where male-dominated images and family socialisation continue to reinforce underrepresentation despite broader progress across STEM. At the same time, younger generations are reshaping career motivation through "stagility": the simultaneous desire for flexibility, innovation and continuous learning, together with security, clear career pathways and supportive management. Purpose, wellbeing, inclusion, empathy and value alignment now play an increasingly important role in attraction, satisfaction and retention, indicating that effective interventions must connect education, workplace culture and institutional policy rather than treating them as separate areas.

4.4 Generation Z (1995–2010)

4.4.1 Motivational factors documented in the literature

Gen Z motivation is documented in more explicitly psychological terms than any earlier cohort. STEM aspirations are consistently linked to self-efficacy, outcome expectations, personal inputs and contextual support, alongside career maturity, occupational exploration, and decision-making readiness, together mapping onto Social Cognitive Career Theory in Chapter 3. Within this, belonging and identity stand out specifically: students' sense of belonging in technology and their perceived ability to succeed are identified as crucial determinants of persistence, alongside pride in studying the field and identification with it (Bairoh & Naukkarinen, 2023). School empowerment and engagement are linked to lower STEM-gender stereotypes

suggesting that belonging operates here as both a motivator in its own right and a protective factor against stereotype internalisation.

Interest, usefulness and competence function as the next layer: interest is the strongest single predictor of technology career aspiration, followed by parental attitudes, perceived utility value, and competence beliefs, with effort cost also a relevant factor. One aspect that appears more prominently in this cohort is the role of personality.: Higher levels of openness are strongly associated with tech aspiration (technology perceived as creative, inventive work). Among girls specifically, higher extraversion is also associated with greater interest in technology careers. Compared with the evidence for earlier cohorts, this represents a more explicit consideration of personality traits in relation to STEM aspirations (Minor et al., 2022).

Early experience, encouragement and role models remain foundational, as in every earlier cohort, but the mechanism is more experiential here than in Gen X or Millennial material: creative and collaborative IT activities, interdisciplinary programmes, and embedding technology into girls' existing social contexts are identified as engagement drivers in their own right, alongside the now-familiar list of family support, female role models, mentoring, girls-only initiatives, and early programming exposure.

Visibility, access and opportunity continue the growth trend already established for Millennials. Higher female participation in education, an increasing proportion of women selecting ICT as their first-choice field, favourable employment prospects, and stronger diversity initiatives are supported by continued investment in STEM education, enrolment opportunities, and policy interventions.

The evidence comparing Generation Z and Millennials in Belgian context (Deloitte, 2025) suggests a shift away from traditional definitions of career success based on hierarchical progression. Instead, younger generations place greater emphasis on financial independence, work–life balance and job stability. This marks a clear departure from earlier career models in which advancement was primarily associated with moving into leadership positions.

Both generations rate purpose as crucial, and happiness tracks a blend of financial security, mental health support, growth opportunities and work-life balance rather than compensation alone, confirming that the values dimension first flagged for Millennials is, for Gen Z, the dominant frame rather than an added layer. A list of motivators reported exclusively by women include meeting interesting people, receiving support, having a "dream job," flexible hours, gaining new experience (Lašáková et al., 2023), indicating that some motivational drivers remain gender-specific even within this values-forward, less hierarchical cohort.

4.4.2 Barriers and challenges documented in the literature

The most persistent barrier is the continued perception of ICT, computer science and engineering as masculine fields. These stereotypes influence girls' interests, confidence and sense of career fit, even when students report that stereotypes do not affect their choices. Male-dominated learning environments, teaching materials, occupational images and unequal encouragement further reinforce this pattern. Gen Z's barrier evidence largely confirms the same mechanisms as Millennials, including male-dominated representations of ICT, weak early exposure, stereotype-driven avoidance. However, one notable refinement is that

stereotypes are increasingly invisible even to those affected by them. Students often claim stereotypes do not affect them, but stereotypes still shape avoidance of gender-atypical choices (Pikić Jugović & Baranović, 2022). Whereas Baby Boomer barriers were primarily structural, Generation X barriers centred more on identity tensions, and Millennial barriers increasingly reflected the active management of those challenges, the Gen Z evidence suggests that stereotypes may have become more subtle and less consciously recognised.

A second recurring barrier is lower self-efficacy and a weaker sense of belonging. Girls frequently underestimate their technical abilities despite performing well academically. Limited practical experience with technology, fear of failure, negative classroom experiences and a lack of female role models can make ICT careers appear inaccessible or unsuitable.

Structural factors also repeatedly restrict participation. These include gender segregation in education, early specialisation and educational tracking (Minor et al., 2022), inflexible study pathways and the continued concentration of women in health, education and service-related fields. These barriers often limit STEM options before students have developed sufficient career maturity to make informed choices.

The evidence also highlights gaps in support and career preparation, including limited information, unclear self-concept, weak career planning, inadequate mentoring and unsupportive workplace cultures. Together, these factors contribute to both low entry into ICT and attrition throughout the education-to-employment pipeline.

More recent evidence introduces additional barriers for younger generations. These include financial pressure, anxiety and burnout, limited workplace mental-health support, fear of job displacement through AI and frustration when work lacks purpose or alignment with personal values: according to Deloitte Belgium-specific survey (Deloitte, 2022), roughly 40% of both generations report frequent anxiety or burnout, about a third feel unsupported by managers, and roughly half still do not use GenAI at work, with many fearing job losses to automation. Unlike earlier findings, this evidence identifies the technology itself, rather than access to technology or exclusion from it, as a potential source of concern.

The Finnish evidence provides the summary of the barriers experienced by this generation, in line with findings from other countries. It suggests that the primary challenge is a lack of belonging rather than a lack of ability, with women and non-binary students reporting lower levels of belonging despite achieving comparable or higher academic performance (Bairoh & Naukkarinen, 2023, 2020). Given the identical structural pattern already seen in Sweden's and Croatia's underrepresentation-despite-competence findings, the gap this report has tracked across four generations is decreasingly about capability and increasingly, now almost entirely, about belonging. Moreover, gender differences in interest persist despite high academic performance among girls, indicating that ability is not the limiting factor. Instead, perceptions of engineering as a field play a decisive role (Naukkarinen & Bairoh, 2020).

4.4.3 Policy and national context across countries

Across the seven countries, the same overarching pattern holds: strong education, equality or labour-market systems do not, on their own, necessarily translate into gender-balanced technology participation. The national evidence for this cohort is best read as a small set of structural mechanisms that recur across borders, rather than as separate country stories.

Early educational tracking, as highlighted in the German context, may further restrict realistic STEM aspirations among students outside higher academic tracks (Minor et al., 2022), and in Croatian context as well, where students make early educational choices around age 14 (Babarović et al., 2016); This represents a structural mechanism that differs from explanations centred on stereotypes or confidence and is not clearly reflected in the evidence for the earlier generations.

The second, and by now the most firmly established finding in the entire report, is the equality paradox: strong labour demand, expanding technical education, and genuinely egalitarian national context all coexist with persistent gender segregation in technology specifically. This pattern is now evident across multiple countries and cohorts, suggesting that it extends beyond isolated national circumstances. Where explanations are provided, they consistently emphasise limited understanding of what engineering and technology careers involve, indicating that improving awareness and career guidance may be as important as expanding educational opportunities.

Overall, the findings highlight the need for early, targeted and gender-responsive interventions that address both structural barriers and gendered perceptions of technology.

4.4.4 Common themes and evolving trends

The Gen Z findings further reinforce the broader trajectory identified across the previous generations. Explanations of gender differences have gradually shifted from individual ability toward socio-cultural and identity-related factors. What first appeared as an emerging perspective in the Baby Boomer evidence became more prominent in the Generation X and Millennial literature and is now widely reflected in the Gen Z research. Career choice is increasingly understood as a long-term developmental process influenced by social, cultural, and contextual factors rather than by ability alone. A related finding is that there is no single "STEM personality." Technology-oriented and natural science-oriented students demonstrate different characteristics and motivations, suggesting that interventions may be more effective when tailored to specific STEM disciplines rather than treating STEM as a single, homogeneous field.

The new concept emerged is "stagility" (Deloitte Belgium, 2025) which describes the desire for both stability and agility within a career. Rather than viewing these goals as mutually exclusive, Gen Z appears to value flexibility, continuous learning, financial security, and predictable career development simultaneously. This directly closes the loop back to the Boomer cohort's "stability-over-passion" motivational logic (Section 1): where Boomers had stability without flexibility as their available option, Gen Z is documented as the first cohort explicitly demanding both at once, rather than choosing between the economic-stability logic of Boomers and the identity/meaning logic that built up through Gen X and Millennials.

Two additional findings contribute to the cohort comparison directly. A study of business students suggests that Gen Z women place relatively greater importance on positive workplace relationships, recognition, and varied work, whereas Gen Z men place relatively greater emphasis on altruistic impact and opportunities for leisure or a low-stress lifestyle. Although this represents evidence from a single study, it provides one of the few direct gender comparisons within the cohort. Finally, the Finnish evidence highlights belonging and identity as particularly important psychological factors for this generation. Together with the broader literature, these findings suggest an increasing emphasis on cultural inclusion and belonging as explanations for gender inequality in ICT, alongside structural and educational factors.

4.5 Generation Alpha (2010–2025)

Important note before this section: Generation Alpha is still school-age. Unlike every earlier cohort, there is no workforce, retention, or career-outcome evidence here. Instead, the available literature focuses primarily on early educational experiences, self-concept, and career aspirations. Consequently, this section should be interpreted as forward-looking, and any comparisons with earlier generations remain tentative.

4.5.1 Motivational factors documented in the literature

Autonomous career motivation, intrinsic and identified motivation, personal vocational development (Babarović et al., 2024) were identified as the primary motivational factors, consistent with the trajectory this report has traced from Boomer economic rationality through Gen Z's values-driven, purpose-forward motivation. One of the most practically relevant findings concerns how motivation develops rather than simply what motivates students. STEM activities that are connected to everyday life and encourage collaboration are associated with higher levels of motivation across students. In addition, psychosocial interventions, such as strengthening self-efficacy and addressing gender stereotypes, appear to have particularly positive effects for girls. Role models work best when perceived as attainable rather than exceptional, and specifically when success is framed as the product of effort rather than innate talent (acatech - Deutsche Akademie der Technikwissenschaften & Institut der deutschen Wirtschaft Köln, 2023). This builds on the "relatable role model" theme identified for Generation Z by providing greater insight into the characteristics that may make role models more effective.

One notable finding comes from comes from Sweden's early-childhood evidence (Wamala-Andersson et al., 2025): no tech or STEM role appears anywhere in girls' top-ten career aspirations, while game developer, YouTuber, and gamer all feature prominently for boys. Despite 90.6% of girls agreeing boys and girls can do the same jobs, this stated belief does not translate into aspiration. The same study also found differences in sources of career inspiration: girls most frequently identified their mothers as role models, whereas boys relied more heavily on media and online sources for career information. These findings suggest that differences in exposure to career information may begin to emerge early in childhood and could influence later educational and career interests.

4.5.2 Barriers and challenges documented in the literature

Barriers here largely confirm, at an earlier age, mechanisms already established for older cohorts, but with two new refinements. First, autonomous motivation itself declines with age, with external pressure from parents, teachers and peers strengthening precisely at transition points. This suggests that some of the "identity management" burden documented for Millennials and Gen Z may originate as a shift away from autonomous motivation that begins in childhood, not something that appears fully-formed in adulthood.

Second, German evidence (Eickelmann et al., 2024) shows a polarisation, not just a gap: girls are overrepresented specifically at the lowest digital-competency level, despite similar or slightly higher average competency overall. This indicates that average scores may mask important differences within the group Related German evidence shows the performance gap in mathematics has widened over time, while the motivation gap remains larger than the performance gap. these findings indicate that psychosocial factors may play an increasingly important role in shaping participation alongside academic ability.

A further contribution of the Generation Alpha literature concerns teachers as well as students. Female teachers report higher technostress, and programming-related activity is more common among male teachers. These findings suggest gendered pattern in technology engagement may also be reflected in the educational environment, potentially influencing students' experiences from an early age. This represents a perspective that is less prominent in the literature on the earlier generations.

4.5.3 Policy and national context across countries

As with the Millennial and Gen Z material, this reads more coherently as a set of recurring mechanisms than as separate national narratives. One important theme is a policy-awareness gap. In German context, (acatech - Deutsche Akademie der Technikwissenschaften, & Institut der deutschen Wirtschaft Köln., 2023) educational research and national data (e.g., IQB-Bildungstrend 2021) shows widening gender gaps in mathematics performance in Germany. Despite awareness of the issue, primary education has not succeeded in reducing these disparities. The report highlights the role of schools, teachers, parents, and policymakers in addressing gendered learning outcomes. It also refers to recommendations by the National MINT Forum (2022), including integrating gender competence in teacher training, promoting female role models, and raising parental awareness of stereotypes.

That broader equality paradox itself receives its most rigorous empirical treatment: in Sweden (Wamala-Andersson et al., 2025) the study was conducted across 28 schools in 14 municipalities in the Skåne region, involving 1,832 children. Despite Sweden's top-ten global ranking in gender equality, gendered career aspirations remain pronounced - a phenomenon the authors term the "equality paradox," whereby differences in tech versus people-oriented aspirations are actually more visible in high-equality, high-wealth countries. Compared to England, Swedish children showed notably limited STEM interest overall. Sweden's national curriculum mandates gender equity from preschool, explicitly stating that a child's opportunities should not be limited by gender. However, the Swedish School Inspection Agency has identified implementation gaps between this policy and classroom reality. The authors argue that existing interventions arrive too late, typically in adolescence, while stereotypes are internalised by age seven, calling for evidence-based STEM

awareness programmes at primary school level. The study also frames early STEM engagement as a matter of national economic competitiveness and sustainable growth.

Another recurring mechanism is early curricular tracking forcing STEM-relevant attitudes to matter before they have fully formed. In systems where students select upper-secondary pathways before the end of middle school, early mathematics attitudes, self-concept, and confidence may become particularly influential in shaping future STEM participation. This reflects the early-tracking mechanism also identified in the Generation Z.

Many countries have introduced digitalisation strategies, competence frameworks, curriculum reforms, teacher-training initiatives and STEM participation programmes. These measures have improved infrastructure and strengthened policy attention to equality and digital inclusion. However, implementation remains uneven. Persistent challenges include limited teacher preparation, insufficient school autonomy and technical support, gaps between national policy and classroom practice, and continuing gender differences despite formal equality commitments.

4.5.4 Common themes and evolving trends

The Generation Alpha evidence further reinforces the broader pattern identified across the previous cohorts: explanations of STEM participation are increasingly moving from cognitive ability toward motivational, psychological, and social factors. Several studies suggest that perceived competence, interest, and self-beliefs may influence STEM choices more strongly than academic performance alone. This is the same shift the Boomer section first flagged as an "evolving trend" and every subsequent cohort has confirmed and sharpened; by Generation Alpha, it is treated as the default explanatory frame rather than a novel finding.

The "things vs. people" dividemis the defining conceptual contribution of this cohort. This provides a more precise formulation than any earlier cohort's stereotype language, and one that explains the Sweden (Wamala-Andersson et al., 2025) aspiration data directly: it is not that girls reject technology, but that they gravitate toward people- and animal-centred roles, while boys gravitate toward "things"-oriented ones, with technology culturally coded onto the latter side of that divide. Framed this way, the equality paradox becomes almost mechanical: a genuinely equal-opportunity society still produces this pattern if the culture continues to code "things vs. people" along gender lines from early childhood.

One broader, non-gender-specific theme concerns the evolution of digital education policy. Research highlights a shift from improving access to technology toward promoting meaningful pedagogical use, growing focus on computational thinking, AI and critical literacy. Covid-19 also accelerated attention to digital inequalities. These developments should be considered separately from gender-specific findings, as not all changes in this cohort’s educational environment are related to gender dynamics.

The clearest closing statement in the entire report comes from Finland's own framing: Generation Alpha represents a critical stage for intervention. Early cultural representations of engineering formed now will shape future participation patterns, and without deliberately broadening those representations, existing disparities are likely to persist rather than resolve on their own. Viewed across all five generations, the central

pattern remains consistent: the challenge appears increasingly less connected to capability and more related to belonging, representation, and the cultural meanings attached to technology careers.

5. Cross-Generational Analysis

The previous chapter examined women's motivation to enter and remain in ICT across generations and national contexts. Building on this evidence, this chapter brings the five cohorts together to identify the broader patterns that emerge across generations and countries and, most importantly, what these patterns imply for policy and practice. It traces a consistent direction of change in how motivations and barriers are experienced, examines a recurring national paradox, and draws out the policy recommendations that follow from both.

The distinctive contribution of a generational lens is that it converts a static gender gap into a **dynamic, time-stamped mechanism**: the same four psychological needs (competence, autonomy, value, belonging) reappear in every cohort, but the report can now show *where in the life course* each need is being unmet and *how the field's own explanatory language* has evolved: from confidence, to identity, to structural and intersectional analysis, often years before policy catches up. This reframing has direct transferability beyond ICT: the "things vs. people" divide, the equality paradox, and the shift from access to belonging are patterns likely to recur in any technically-coded, historically male-dominated field, and the intervention logic proposed here (earlier timing, redefinition of valued competencies, retention parity, attainable role models, teacher-level intervention, multi-level policy alignment) offers a replicable template for future sector-specific research and for the survey and interview phases that follow this literature review. A table below summaries the main cross-generational findings:

Table 1-Main Findings Summary Table

Generation	Main motivation	Main barrier	Dominant intervention
Baby Boomers (1946–1964)	1.Economic security and labour-market demand; 2.Competence and practical usefulness of technology; 3.Personal autonomy; ***Motivation shaped more by economic security than by identity or personal fulfilment***	1.Gendered socialisation and low technology-related confidence 2.Limited early **exposure** to technology (ICT had not yet been formally defined as a unified sector) 3.Male-dominated educational and workplace environments **Historical note:** Women made significant inroads into computer science in the 1970s and early 1980s, before PC marketing towards boys, "hacker" culture, hiring bias and workplace exclusion	Gender-equality legislation and national reskilling strategies addressed workplace and policy barriers but largely missed the early-exposure stage where gendered patterns originated, reflecting the Boomer cohort's predominantly workplace-level interventions.

		reinforced its masculine image (CEPIS, 2025).	
Generation X (1965–1979)	1.Career growth opportunities, mentoring and female role models 2.Interest and career prospects 3.Professional identity alignment-aligning personal values with "being an engineer" ***Alignment between personal values and professional identity***	1.Gender bias throughout STEM higher education; early-formed stereotypes and lack of encouragement toward ICT; 2.Workplace/retention barriers (glass-ceiling effects, "prove-it-again" bias, maternal-wall dynamics); 3.Cultural and identity-based tensions - friction between technical/ masculine engineering norms and women's social/communicative interests, reducing career-fit confidence (Naukkarinen & Bairoh, 2022)	Computer-Supported Collaborative Learning (CSCL)-role design, collaborative scripts, socio-cognitive conflict (Kube et al., 2024) - described as "the clearest actionable mechanism the Gen X literature offers," with no direct Boomer-cohort equivalent**.** Workplace-level mitigations also emerge: sabbatical policies, flexible arrangements, mentoring, equal pay.
Millennials (1980–1994)	1.Active alignment with personal values (Meaningful work, ethics and sustainability become explicit motivational factors in their own right, not secondary to economic or identity concerns) 2.Intergenerational resource transfer (Family-transmitted exposure). 3.Belonging, self-efficacy and identity converge as a positive motivational cluster ***(Shift from identity-as-friction to identity-as-fuel)***	1.Masculine coding of ICT/STEM/engineering (the "geek/gamer" stereotype; “things-oriented” rather than people-centred field; tokenism and the assumption that women were hired mainly to meet diversity targets); 2.Gender gap in confidence and technical self-concept despite comparable performance, shaped by early gendered choices and unequal encouragement. 3.Technical/social dualism, in which technical competence is prioritised while social and communicative dimensions are	The dominant theme, carried forward and deepened from Gen X, is the gap between formal equality policy and lived workplace outcome: the equality paradox. Policies supporting women's ICT participation are most relevant when they combine early technology exposure, education and mentoring, gender-equality measures, workplace support and opportunities for continued participation.

		marginalised, sharpens from felt tension (Gen X) into actively managed identity performance; 4.Family responsibilities; ***Shift from understanding underrepresentation primarily as a matter of individual skill or choice towards recognising a multi-level system of barriers spanning early socialisation, confidence, education, recruitment, organisational culture, career progression and family responsibility.***	***Pre-primary and early primary school emerge as the critical window before stereotypes solidify, since a single well-designed intervention in adolescence cannot undo years of prior cumulative messaging about who technology is for.***
Generation Z (1995–2010)	1.Gen Z motivation is documented in more explicitly psychological terms than any earlier cohort: students' sense of belonging, value alignment and identity stand out specifically. 2.Interest as a single predictor of ICT career aspirations (creative and collaborative IT activities, interdisciplinary programmes) 3.Financial independence, work–life balance and job stability (swift from hierarchical progression) Sense of purpose, happiness tracks a blend of financial security, mental health support, growth opportunities and work-	1.Subtle stereotypes and masculine coding: often influence choices unconsciously. 2.Lower confidence, belonging and exposure: weaker technical self-concept and limited hands-on experience. 3.Structural education barriers: gender segregation, early tracking and inflexible study pathways. 4.Limited support and guidance: insufficient career information, role models and encouragement. 5.Workplace pressures: financial stress, burnout, AI-related job insecurity and lack of purpose.	Strong education, equality or labour-market systems do not, on their own, necessarily translate into gender-balanced technology participation (equality paradox). Early educational tracking and early educational choices may further restrict realistic STEM aspirations. Limited understanding of what engineering and technology careers involve; (soft side of ICT professional should be more highlighted). Need for early, targeted and gender-responsive interventions that address both structural barriers and gendered perceptions of technology.

	life balance rather than compensation alone,		
Generation Alpha (2010–2025)	1.Autonomous career motivation, intrinsic and identified motivation, personal vocational development. 2.Competence beliefs, expectations of success, intrinsic value, utility value, attainment value. 3.Enjoyment and interest in digital tasks; self-confidence/self-efficacy; teacher support and motivational scaffolding. 4.Playful and project-based digital learning; collaborative digital activities; alignment with prior interests; digital engagement. 5.Interest in STEM careers; female role models; career awareness; STEM opportunities.	1.Autonomous motivation declines during adolescence, while external pressure from parents, teachers and peers becomes stronger near transition points. 2.Lower confidence and gendered motivation: girls report lower maths self-concept, interest and confidence, while motivation gaps are often larger than performance gaps. 3.Early stereotypes shape choices: gender stereotypes are internalised from an early age, steering girls away from STEM and technology-related pathways. 4.Unequal digital opportunities: uneven digitalisation, infrastructure and access to digital tools can limit equal opportunities and contribute to competency polarisation. 5.Gendered educational environment: evident on the teachers' side as well.	**Early educational transitions**: need for personalised career counselling and early attention to attitudes towards maths and STEM. **Digitalisation policy and implementation gaps**: strong national frameworks and investment coexist with uneven implementation, limited school autonomy and continued need for infrastructure, teacher training and IT support. **Gender-responsive education measures:** gender competence in teacher training, female role models and parental awareness of stereotypes. **Equality paradox:** strong gender-equality frameworks can coexist with pronounced gendered career aspirations and persistent participation gaps. **Need for earlier intervention:** existing interventions often arrive too late, supporting STEM awareness programmes from primary school level.

The data traces a consistent shift: barriers have moved earlier in the life course and become less visible, while motivational drivers have moved from external/economic to internal/psychological. What hasn't changed is the gap between formal equality and actual participation, the "equality paradox", suggesting that the mechanisms of exclusion have adapted faster than the policies meant to counter them.

Important note to keep in mind, there is no unique path leading women to ICT professions, contrary to men's paths, which are strongly determined by their initial training curriculum (Vendramin, 2004). Among women working in ICT, there are science and engineering graduates, as well as graduates who have studied economics, humanities, journalism, and arts. Moreover, in all countries, many women entered the ICT professions from other occupations in the same organisation, after re-training, or resulting from a reconversion process (retraining, reorientation) in the labour market (Valenduc, 2011). **Presenting ICT as an interdisciplinary field with multiple entry routes can make it more accessible and relatable to women with diverse educational and professional backgrounds, while promoting reskilling and career-change opportunities can widen participation beyond traditional technical pathways.**

A recurring national paradox

A recurring pattern across the evidence is the mismatch between **formal equality and lived participation**. Strong legislation, high female academic performance and well-resourced STEM policies often coexist with persistently low participation in engineering and ICT. This suggests that formal progress does not automatically translate into equal engagement. In some contexts, the underlying mechanisms are already well understood and targeted interventions, such as teacher training, role-model initiatives and awareness campaigns, are in place, yet the gap continues to widen rather than close. The issue, therefore, is not only whether the problem has been identified, but whether existing measures reach the point at which the barrier is actually formed. Where the motivation gap exceeds the performance gap, the constraint appears to be psychosocial rather than ability-based, while evidence that educators themselves can reproduce these patterns shows that the problem is embedded in the wider learning environment, not only in individual students.

A further challenge is the **fragmentation of smaller-scale efforts**. Outreach schemes and corporate diversity commitments often operate independently of national policy and of one another, limiting their cumulative effect on participation.

Where structural and economic barriers are weakest, the remaining cultural barriers become more visible. The gap does not disappear; instead, capable women show lower levels of interest despite comparable ability, while engineering is experienced as a narrow, technical culture rather than as one branch of a broader scientific field. Once structural explanations are largely removed, what remains is identity misalignment, an undervalued hierarchy of skills and a sense of belonging tied to the discipline itself rather than to any single institution.

The evidence also points to an **early-education origin for these patterns**. Perceptions of engineering, professional identities and the values associated with the field begin to form through the way technology and

engineering are introduced and represented from a young age. This means that factors relevant to later participation and retention are often established before most policy interventions begin.

One particularly important mechanism is the **artificial separation of technical and social competence**. When communication and collaboration are treated as secondary to technical mastery rather than as integrated professional skills, women whose strengths and interests include these dimensions may experience greater identity misalignment and weaker belonging, increasing the likelihood of disengagement or exit.

The conclusion this evidence supports is correspondingly precise: **retention is not primarily a matter of access or opportunity, but of alignment between individuals and the culture of the profession**. Increasing participation or adding structural support is not sufficient on its own; what is required is a redefinition of engineering culture itself, so that a broader range of competencies, identities and contributions is made visible and valued. Finland's experience illustrates both what policy can achieve and what remains unresolved when cultural norms and identities are left unchanged.

The persistence of this paradox can largely be explained by a mismatch in timing. Policy tools such as legislation, funding and monitoring are primarily designed to intervene at the moment of deliberate choice : what to study or which job to apply for However, perceptions of belonging, competence, and career identity often develop much earlier through family, media, schooling, and social environments. The challenge may therefore be less about a lack of policy attention and more about ensuring that interventions reach the stages where these perceptions are first formed.

Emerging policy recommendations

The cross-generational arc points toward interventions timed to the life-course stages this report has identified, rather than a single access-focused fix:

- **Move interventions earlier.** Since stereotype internalisation now appears by age seven (Generation Alpha) and structural tracking locks in choices by ages 10–14 (Germany, Croatia), compulsory, non-elective technology exposure from ages 4–7, as proposed in the HER TECH Gender-Sensitive Engagement Framework's "Access" pillar, should precede, not follow, formal tracking decisions.
- **Redefine the field, not just recruitment into it.** Reframing ICT as communal, people-oriented and socially beneficial (Expectancy-Value Model) measurably increases female interest; policy should recognise communication and collaboration as core technical competencies rather than secondary "soft skills".
- **Treat retention as equally important as access.** Sabbatical policies, flexible time/location arrangements, transparent promotion criteria and active mentorship address the entry-to-retention shift documented from Millennials onward, and directly counter tokenism and "prove-it-again" bias.
- **Make role models attainable, not exceptional.** Effort-framed, relatable role models (Generation Alpha evidence) outperform showcasing rare high-achievers; family-based exposure - mothers in

STEM, technically engaged fathers - should be treated as a distinct, fundable lever alongside school-based mentoring.

- **Address teachers as well as students.** German evidence shows female teachers report higher technostress and lower programming engagement, meaning the gendered pattern is partly reproduced by educators; teacher training in gender-competent pedagogy is a prerequisite for any classroom-level intervention.
- **Pair legislative equality with organisational and educational mechanisms.** Because the equality paradox recurs regardless of the strength of national frameworks, policy must operate simultaneously at national, institutional and classroom levels (Group Concept Mapping evidence from German STEM universities); legislation alone has repeatedly proven insufficient.
- **Develop gender-aware, intersectional monitoring.** Socioeconomic background, migration status, disability and geography all modulate how these mechanisms operate; data collection and evaluation should disaggregate accordingly rather than treating "women in ICT" as homogeneous. It should also recognise non-linear career paths, including career-changers and women returning after time away, and the value of age-diverse teams and reverse mentoring.

Moreover, as highlighted by experts in the previous rounds of interviews, current statistics often rely on narrow occupational classifications, excluding women in digital and technical roles that fall outside formal ICT categories. As a result, the reported gender gap may not fully reflect the actual picture.

This chapter analysis confirms that the gender gap in ICT has not disappeared or narrowed, it has shifted in form: from primarily structural barriers toward increasingly cultural, identity-related, and psychological mechanisms. The survey and interviews that follow this literature review will provide an opportunity to examine how women themselves experience these mechanisms across generations and countries, whether the patterns identified in the literature are reflected in lived experiences, and how future recommendations can be refined through empirical evidence.

Conclusion

Across generations, women's participation in ICT and technology shows a clear transformation. Motivational factors have moved from economic and employment considerations towards value-driven engagement, identity and belonging, while barriers have shifted from visible structural exclusion towards cultural, psychological and identity-based challenges. Although policy contexts have improved significantly, persistent disparities show that formal equality and access alone are not sufficient.

The main added value of this review is its cross-generational and cross-country perspective. By tracing five generational cohorts across seven partner countries, it shows that the gender gap is not static, but changes across the life course and in response to different social, cultural and institutional conditions. Earlier cohorts faced primarily structural barriers, while for younger generations stereotypes, competence beliefs and perceptions of whether ICT is "for someone like me" are formed increasingly early, reaching into childhood and primary education.

Several mechanisms remain consistent across generations: the continued dominance of masculine engineering culture, the technical/social dualism, and the undervaluation of skills and interests more commonly associated with women. The recurring "gender equality paradox" where strong formal equality frameworks coexist with persistent segregation, further illustrated that structural progress does not automatically translate into equal participation.

These findings point towards a shift from access-focused measures to inclusion and cultural transformation. Policy and practice need to address how ICT and engineering are represented, which competencies are valued, who is perceived as belonging, and what is recognised as professional success. An intersectional approach is also needed to reflect how gender interacts with age, socioeconomic background, geography, disability and migration background.

This literature review cannot fully determine whether these patterns reflect women's lived experiences. The next phase of WP4 will address this limitation through surveys and interviews, examining the relative importance of the motivational factors and barriers identified here and exploring how family influence, role models, belonging, workplace culture and the technical/social dualism operate at decisive moments. The comparative analysis will then distinguish cross-generational drivers from cohort- and country-specific factors and translate the findings into differentiated policy and pedagogical recommendations, directly informing the HER TECH Gender-Sensitive Engagement Framework and subsequent policy-oriented work.

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