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THAI DEVELOPERS: SKILLS, DIVIDES, AND CHALLENGES

THAI PROGRAMMER
สมาคมโปรแกรมเมอร์ไทย

The Asia Foundation

Thai Developers:

Skills, Divides, and Challenges

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Executive Summary

This report presents the results of the 2023 Thai Developer Survey, conducted by The Asia Foundation and the Thai Programmers Association among 1,865 developers in Thailand. The survey provides further evidence of persisting gender and regional divides among digital economy professionals. In addition, this study provides an overview of the specific programming languages and expertise in across a broad range of technologies among Thai developers.

Women make up only 16.7 percent of Thai developers, a much lower rate than comparable occupations such as science and engineering professionals (28.4 percent), ICT professionals (26.6 percent), or ICT technicians (20.5 percent). Moreover, this survey shows that women's participation as a share of total developers does not increase in younger generations. The study also provides evidence that women are more heavily represented at lower salary tiers than men among Thai developers.

The study found that the developer community in Thailand is concentrated in Bangkok. Bangkok represents 65 percent of the country's programmers, with nearly half of the developers migrating from other parts of Thailand. The unemployment rate among developers is more than double in provinces compared to Bangkok. Furthermore, this study also found that developers in Bangkok are more likely to earn salaries in the upper tiers (100,000 THB or more) than those in the provinces outside Bangkok. Similarly, among Bangkok residents, developers born in Bangkok are more likely to perceive salaries of 100,000 THB or more than those born outside of Bangkok, suggesting additional potential job market frictions such as the importance of personal networks to accessing the best paid jobs.

Regarding specific skills, this study shows an alignment between Thai developers and global trends, with a prevalence of SQL, HTML, JavaScript, and Python as the most utilized programming languages. Hence, challenges in the industry due to the improvements of Generative AI in coding language are shared between Thai developers and the rest of the world. Additionally, this report shows the underutilization of expertise in specific topics, such as AI, cybersecurity, IoT, and robotics.

This report also serves to outline measures that help Thai developers upskill and reskill. Aligned with other studies, the 2023 Thai Developers Survey shows that lack of time is the most prevalent barrier to upskilling. Language also provides a considerable constraint to upskilling. Developers in Thailand are

predominantly university graduates, but English knowledge is not widespread (only 22 percent of respondents declared advanced or working proficiency of English). Only 33 percent of developers stated that they can easily access information in Thai to improve their skills.

The results can help to frame efforts to boost Thailand's economic growth by expanding the penetration and benefits of the digital economy. In addition, the findings of this study provide an evidence-based assessment upon which to implement pilot programs to address the gaps identified in this study. For example, programs to improve internal migrant's access to job opportunities, expand women's participation and access to higher-paid jobs, and test new approaches to address time constraints and language accessibility in upskilling and retraining programs.

1. Introduction

The growth of Thailand's digital economy has played a pivotal role in the country's economic and social transformation in recent years. Thailand's digital economy is one of the most dynamic among ASEAN Member States (AMS), with 9 million new digital consumers since the start of the COVID-19 pandemic (ISEAS – Yusof Ishak Institute, 2023). The country's economic growth is also deeply intertwined with how the digital economy will perform, with initiatives such as the Digital Wallet having the potential to positively impact the country's short-term economic growth (World Bank Group, 2023). Moreover, recent forecast analyses project that the gross market value of the digital economy in Thailand will increase threefold by the end of the decade, totaling at least US $100 billion (Google, Temasek, and Bain & Company, 2023).

As the expansion of the digital economy increasingly impacts Thailand's growth, it is worthwhile to assess the skilled workforce in this sector. In terms of skills demands, Thailand has followed regional trends as the post-pandemic economy has shifted towards a set of specific programming qualifications. For example, using LinkedIn, the Asian Development Bank (ADB) calculates that software engineering is the top job in demand in India, Malaysia, Singapore, and the United States, and number two or three in Australia, Indonesia, and the Philippines (ADB, 2022). On the other hand, despite the rising demand for highly skilled digital jobs worldwide, some challenges are pervasive, such as the low share of women in the sector, and the decreasing trend of absorbing youth in IT jobs (ILO, 2022). Another trend relevant for Thailand is that the concentration of growth in the digital economy in centered in Bangkok; with 67 percent of the country's digital consumers (ISEAS – Yusof Ishak Institute, 2023), and leading the e-commerce supply (Google, Temasek, and Bain & Company, 2023).

An estimated 34.4 percent of the Thai workforce, roughly 12.9 million, is engaged in the digital economy workforce (ISEAS – Yusof Ishak Institute, 2023). Developers in Thailand amounted to nearly 550,000 individuals in 2022, with 144,672 people working on software services, 324,760 on hardware and smart devices, 73,782 on digital services, and 6,225 on digital content (Jongwanich, 2024)[1].

[1] The study defines developers, software engineers, designers, and similar specializations as "digital industry professional workforce."

Despite the significant size of Thailand's digital industry professional workforce, there is uncertainty about the sector's future mainly due to the increasing adoption of generative artificial intelligence (GenAI) tools. GenAI models can create faster and more efficient codes and be used to mainstream specific tasks such as website creation, graphic design, or data cleaning. For example, a study with software developers using GenAI tools to implement an HTTP server in JavaScript proved to be 55.8 percent faster than software developers not using GenAI (Peng, Kalliamvakou, Cihon, & Demirer, 2023). The productivity enhancement of using GenAI among software developers works by automating part of the software developer's repetitive tasks, improving existing functions of the job (e.g., increasing and augmenting the quality of services offered), and creating new tasks, such as data privacy and security protocols, and real-time decision-making (Ellingrud, et al., 2023).

However, there is no consensus on which direction GenAI will affect the future job market demand for software developers and other digital economy professions. Some studies use data repositories on occupational abilities (such as the U.S. Department of Labor Occupational Information Network, O*NET) to determine the likelihood of exposure to AI, where industries such as computer system design, data processing, and hosting, or software publishers are indeed among the most exposed to GenAI (Felten, Raj, & Seamans, 2021). Using the same data source, the Pew Research Center identifies web developers and data entry keyers as two of the most exposed occupations in the U.S. due to AI (Kochhar, 2023). On the other hand, some job demand analysis projects that computer systems analysts and programmers are among the most resilient and growing occupations, with a significant boost in their demand by 2030 (Ellingrud, et al., 2023).

In an environment where the future of developers is uncertain, it is important to provide further evidence for decision makers. This report provides an assessment of Thai developers, or highly skilled digital economy workers. The objective is to gather information to map Thai developers' skills, job market participation, potential income divides, and perceptions of key policy issues. The definition of what constitutes a developer is broad and self-defined, as the subjects of this analysis were members of the Thai Programmers Association (TPA). The TPA is a nonprofit organization dedicated to advancing the interests and skills of Thai programmers, with a membership of 40,000+ Thai developers (programmers, software engineers, designers, and data analytics professionals, among others).

The report is structured as follows: Section 2 succinctly describes the survey's methodology and scope. Sections 3 to 7 show the main findings of the survey according to the key demographics, range of skills of the Thai developers surveyed, employment and job market statistics, income levels, and perceptions of Thai developers, respectively. Finally, the report concludes by summarizing the key findings and lessons.

2. Methodology

In partnership with the TPA, The Asia Foundation conducted an online survey between December 2022 and March 2023. All TPA members were eligible to take part in this study. Respondents were incentivized to participate in this assessment by providing the option to access prizes, such as hardware and small vouchers[2]. The survey collected 1,925 responses from 1,865 unique individuals. Under the randomization assumption, and considering a basis of 40,000 TPA members, this would mean a margin of error of ±2.22% at a 95% confidence level, assuming maximum variability in the population's responses.

The questionnaire was conducted in Thai and consisted of five sections, totaling more than 30 questions. The first section was oriented to collect demographic information, such as age, gender, and region where the coder was born and the region where currently lives. Respondents were later asked about employment and job market information, providing information about their current job status, type of employer, position, salary, and province, and working from home information. Section three consisted of specific skills (i.e., knowledge of specific programming languages and expertise in emerging technologies) and formal training acquired by the developers. The two final sections of the questionnaire included perception questions about the digital economy ecosystem and future career development issues.

The subsequent sections of this document shows the key results of the survey, based on the findings relevant to decision makers[3].

[2] Hence, one limitation of the data collection process was the non-randomization of the sample.

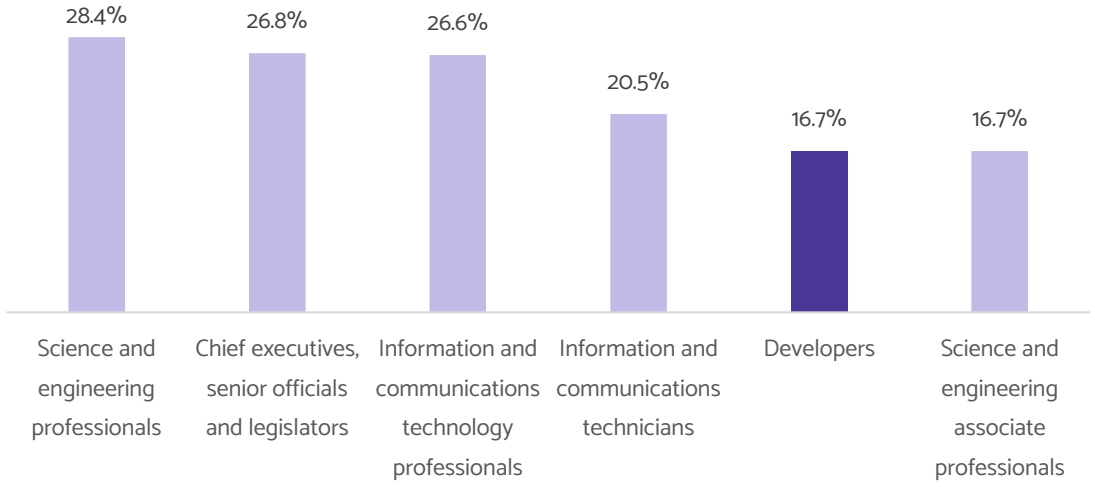
[3] Other possible crosstab analyses not shown in the document are not displayed because they did not exhibit relevant findings.

3. Key demographics of Thai developers

3.1. Women's participation is below comparable occupations

Only 16.7 percent of Thai developers are women, which is far lower than the participation rate found in other occupations in the digital economy and science, technology, engineering and mathematics (STEM) sector. Figure 1 shows the survey results regarding women's participation and contrasts it with other similar occupations, such as science and engineering professionals and associates, C-level positions, and IT professionals and technicians. The share of women among Thai developers is only comparable with STEM associates, with an equal ratio of 16.7 percent.

Figure 1. Women's participation in skilled and digital jobs in Thailand



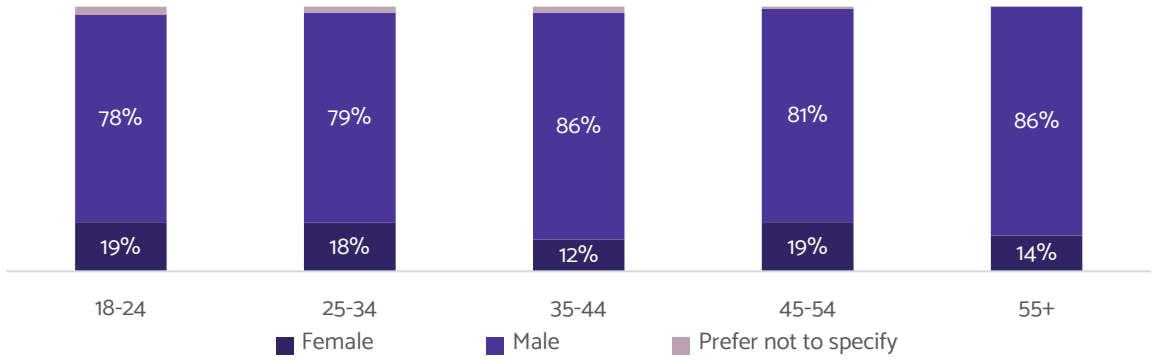
Source: own elaboration and ILOStat data for Thailand (2022, occupation at 2-digit level)

3.2. No increase of women's participation in younger generations of coders

The low share of women in the IT and other information services sectors is a global issue beyond the Asia and the Pacific region (ILO, 2022). Although 68 percent of 12-14-year-old girls in the region express interest in STEM, only 19.3 percent of women graduates obtain STEM degrees (USAID and ASEAN, 2022). Moreover, the present study shows that notwithstanding all efforts in increasing women's participation as highly skilled digital economy workers, younger generations of Thai women do not have a higher share of participation vis-à-vis men. According to Figure 2, there is nearly no growth in women's participation in the 18-24 and 25-34 age groups. Although there is an increase in the immediate

subsequent age group of women between 35-44, this seems to be an outlier since the 45-54 year-old women have a similar participation ratio (19 percent) compared to the younger groups.

Figure 2. Thai developers, by gender and age group



Source: own elaboration

It is important to note that Thai developers are largely concentrated in the age group of 34 years old or below (see Table 1). The 18-24- and 25–34-year-old segments combined represent nearly two-thirds of Thai developers based on this survey's data, it is unlikely to observe major shifts in women's participation in the next few years. This trend could be reversed, considering recent studies show that women represent 53 percent of STEM researchers (Aware, 2023). However, in 2017, women represented 48 percent of technology graduates (Boston Consulting Group, 2020), which is not reflected among developers between 25 and 29 years old in the current survey.

Table 1. Concentration of Thai developers by age group

Age group	Share out of total
18-24	17%
25-34	47%
35-44	26%
45-54	8%
55+	2%

Source: own elaboration

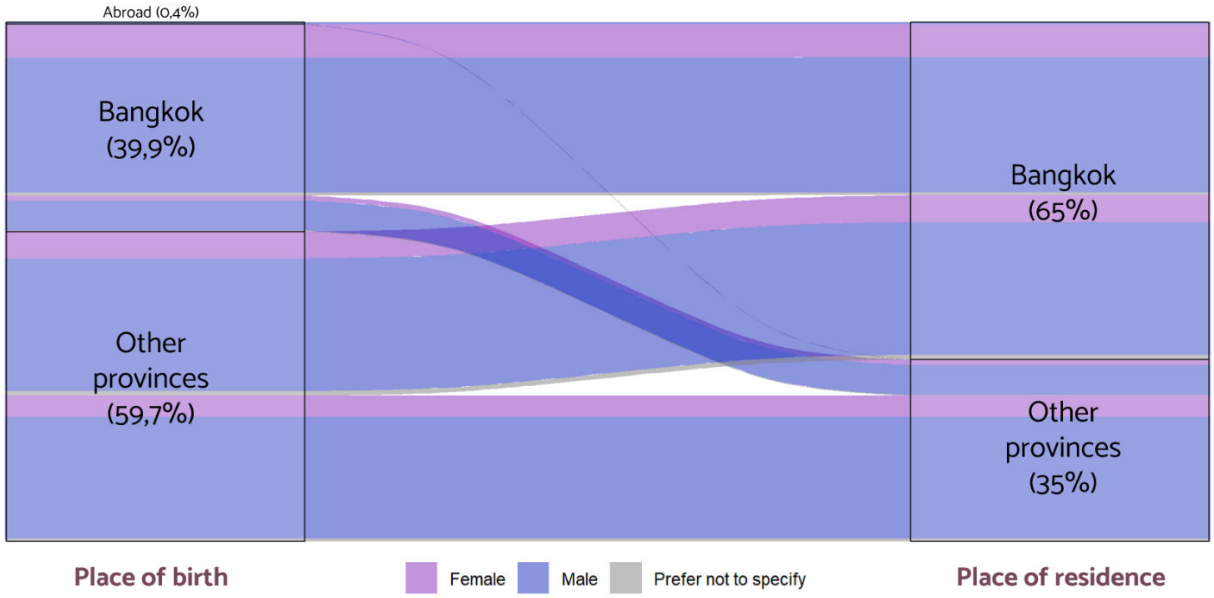
3.3. Migration patterns: the hollowing out of provinces vs. the rising of a Global Bangkok

The growing gap between metro and non-metro areas in Southeast Asia is consistent among countries in the region. Moreover, this is a driver of the digital economic divide, hampering the potential benefits

of digitalization in provinces. The e-Conomy SEA report (Google, Temasek, and Bain & Company, 2023), for example, provides evidence of the gap between the average indicators across selected capitals (Bangkok, Hanoi, Jakarta, Kuala Lumpur, Manila, and Singapore as a whole) and the rest of the country. The study shows that consumers in capital cities have higher digital literacy and spend 1.5 times more on e-commerce than non-metro consumers. In Thailand, 60 percent of high-value users[4] are concentrated in the Bangkok metro area.

Regarding the supply side of the job market, the main motivation for the agglomeration of highly educated workers in Thailand is employment opportunities. Tertiary studies are also linked to increase the likelihood of migrating to cities (Paweenawat & Liao, 2023). The 2023 Thai Developers Survey included questions about place of birth and current place of residence, providing further insights on the migration patterns of highly skilled Thai digital workers. Figure 3 shows that while nearly 60 percent of Thai developers were born outside Bangkok, 65 percent of the total were residing in the capital when surveyed. In other words, 53 percent of Thai developers born in the provinces migrated to Bangkok[5].

Figure 3. Place of birth and place of residence of Thai Developers



Source: own elaboration

[4] High-value users, or HVU, is defined as the top 30 percent of online spenders. In Thailand, HVU spend in average 7x more than non-HVU.

[5] 17 percent of developers born in Bangkok reported residing outside Bangkok.

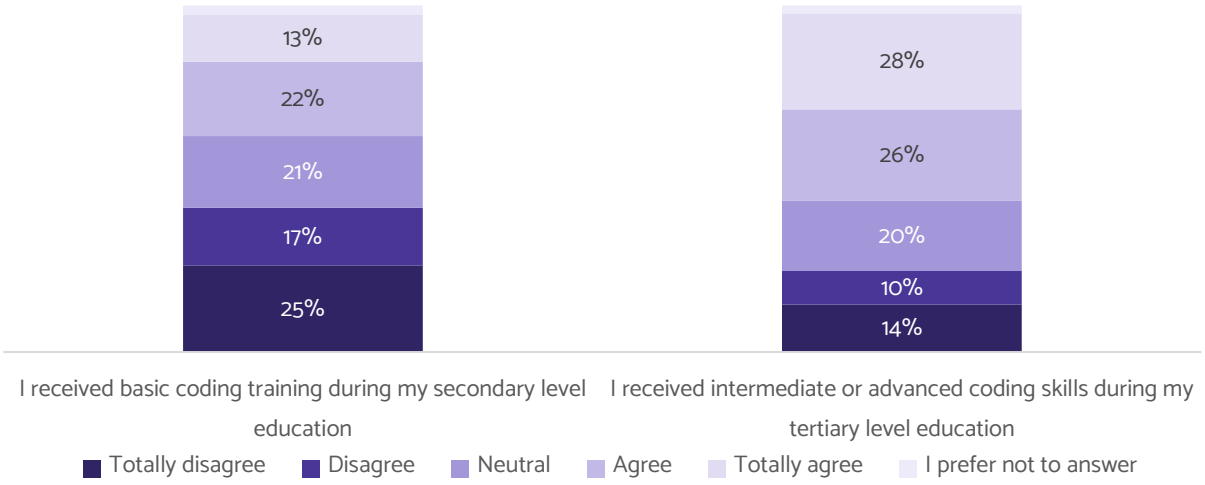
4. Skills of Thai Developers

4.1. Coding training during secondary and tertiary education

The survey included questions about the type of coding training Thai developers received during secondary-level education (Matthayom 1-6) and during formal training (higher education or vocational training). As presented in Figure 4, only 35 percent of Thai developers reported[6] that they received basic coding training during secondary education (Matthayom). However, more than half of developers (54 percent) indicated that they received intermediate or advanced coding skills deriding their tertiary education.

As with many countries after the COVID-19 pandemic, Thailand has been scaling its efforts to integrate coding into school curricula to better equip the next generation with software programming skills. In December 2023, the government launched the program Coding for Better Life: Building the Foundation for Thailand's Future, a collaborative initiative between the Ministry of Digital Economy and Society, the Digital Economy Promotion Agency (depa), and the Digital Ecosystem Promotion Unit. This program expects to train 100,000 students annually by setting up 1,500 digital classrooms and coaching 3,000 schoolteachers on 20 different coding-related skills (The Nation, 2023).

Figure 4. Coding training received during secondary and tertiary education



Source: own elaboration

[6] Respondents answering "totally agree" or "agree."

4.2. Formal education and English language knowledge

Most Thai developers surveyed received tertiary education, which follows the sample's demographic: highly specialized software engineers, designers, developers, and other professionals under the programmer category. Out of the total of respondents, 70 percent completed an undergraduate degree or vocational training, and 25 percent reported having completed a postgraduate degree. These results are aligned with job market assessments that identify the prevalence of higher education institutions to access specialized digital skills in the region (ADB, 2022).

Another relevant skill set for acquiring programming abilities is knowledge of the English language. Since English is ubiquitous in programming languages and commands, developing highly qualified skills in this field poses challenges for non-native English populations. In that context, the 2023 Thai Developers Survey reported that 17 percent of respondents managed basic knowledge of English, 60 percent intermediate, and 22 percent advanced or working proficiency. Only outliers (less than one percent), reported no knowledge of the English language. English and programming languages do not have a unidirectional relation, positively reinforcing the learning of both languages. For example, some non-native English speakers reported being motivated to improve their English language skills while learning programming (Guo, 2018).

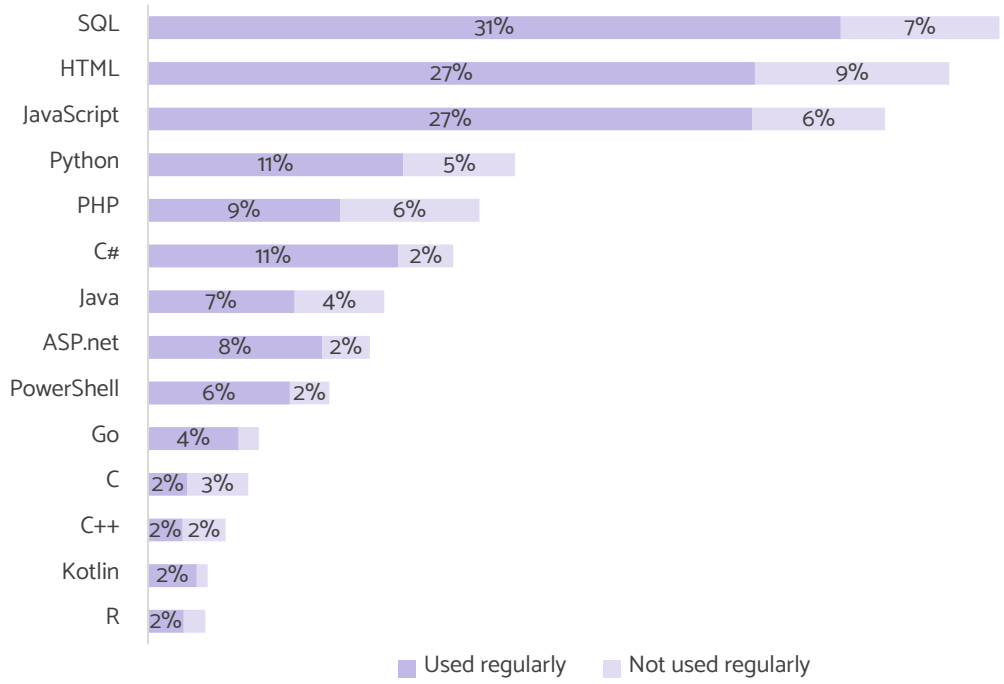
4.3. Expertise in specific coding languages

Respondents were given a list of 29 programming languages and had to self-assess their expertise with each of them (no knowledge, basic or intermediate, expert, or non-applicable). In addition, respondents had to declare if they use the specific programming language regularly or not. The majority of respondents are self-declared experts in SQL (38 percent), HTML (36 percent), and JavaScript (33 percent), which are programming languages characterized by their focus on web development, accessibility, community support, and interoperability (see Figure 5). Thai developers also predominantly declared that they use the specific coding language they have expertise in at their workplace.

These results align with global trends regarding the most ubiquitous coding languages. Stack Overflow, a renowned website and community for programmers and developers, gathered more than 80,000 responses among their users around the world, and the top four programming languages, JavaScript,

HTML/CSS, Python, and SQL, are also reflected in Thai programmers' priorities shown in this report (Stack Overflow, 2023).

Figure 5. Self-declared expertise in specific coding languages



Source: own elaboration

** Only considers variables above 3%*

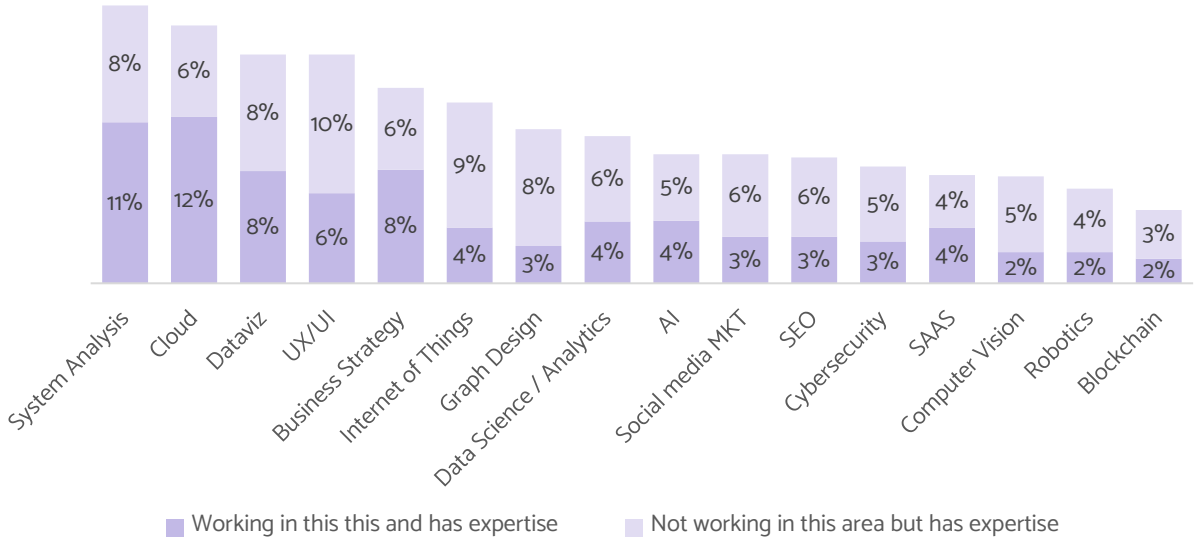
4.4. Expertise in emerging technologies

Despite the difficulty of assessing the expertise in specific emerging technologies, the survey included a set of questions to capture self-assess expertise and help identify job market gaps. Artificial intelligence (AI) positions for example, look for candidates with a range of technical skills, such as knowledge of statistics, specific programming languages, and data analytics, as well as socio-emotional and foundational skills, such as problem-solving approaches, management, and leadership (Borgonovi, et al., 2023). Moreover, the skills needed for emerging technology adoption are also fast-changing and driven by market dynamics; for example, while scarcity of skills drives remuneration increases, it also incentivizes employers to seek automation technologies (Helen, Brian, Cecily, Grace, & Pantelis, 2023).

In that context, respondents were asked to self-assess their abilities[7] in specific emerging technologies, such as cloud computing, Internet of Things, AI, cybersecurity, and robotics. Each category considered a significant breadth of skills, knowledge, and types of technology applications. Additionally, respondents had to declare if they were currently working in that specific area or with the specific technology asked.

Figure 6 presents the distribution of self-declared expertise in specific areas and emerging technologies. A share of Thai developers expressed having expertise in key emerging technologies, such as the Internet of Things (13 percent), AI (9 percent), cybersecurity (8 percent), and robotics (6 percent). However, in all these four categories, self-declared experts do not predominantly work in the area. For example, out of all self-declared experts on AI, over half do not currently work in the field.

Figure 6. Self-declared expertise in specific emerging technologies



Source: own elaboration

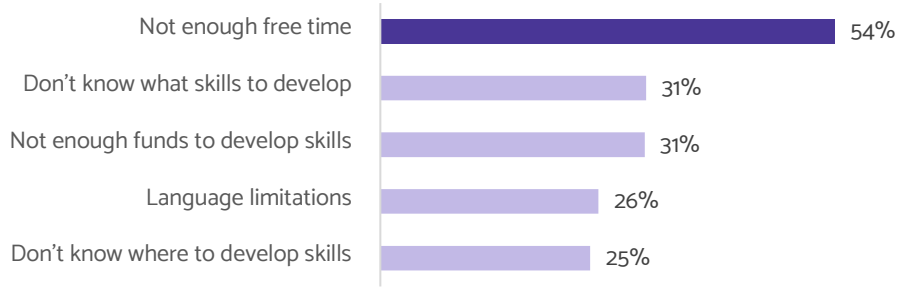
** Only considers variables above 3%*

[7] Self-assessment of expertise is not exempt from limitations. On the one hand, respondents might overstate their expertise in specific programming languages of technology fields, particularly if they are working on them. However, the responses might also go in the other direction, assessing that they are less skilled than their peers, hence declaring that they have a basic or intermediate level of knowledge despite being experts in the field.

4.5. Lack of time availability is the most recurring barrier for upskilling

Time constraints have been consistently the main barrier to accessing upskilling opportunities. The Economist Impact survey of Thai employees in 2022 found that lack of time was the most recurring challenge to accessing both digital and analytical skills (Economist Impact, 2023). The lack of free time to attend upskilling sessions also affects other demographics in Southeast Asia, such as micro and small entrepreneurs in Cambodia (The Asia Foundation, 2023). Accordingly, the findings among Thai developers follow this trend; Figure 7 shows that not having enough time is the main limitation for programmers to improve their coding skills (54 percent of the total). The lack of information and funds were the second and third most recurring limitation, with 31 percent of respondents highlighting this barrier. As mentioned previously, 60 percent of developers declared having an intermediate level of English knowledge, and 17 percent declared basic proficiency. Of the developers with an intermediate level of English, 25 percent perceived language limitations as a barrier to upskilling, while 58 percent of those with basic knowledge shared that perception.

Figure 7. Limitations for improving coding skills



Source: own elaboration

5. Working as a developer

5.1. The share of unemployed developers in Bangkok is much lower than in provinces

More than 78 percent of the survey respondents declared having at least one full-time job (see Table 2), while 7.2 percent were entrepreneurs or self-employed, 6.1 percent were part-time employees, and 8.5 percent were unemployed. However, the regional disparities in unemployment rates are revealed considering the place of residence. While 6 percent of developers residing in Bangkok are unemployed, this ratio increases to 13 percent among residents outside the capital (see Figure 8).

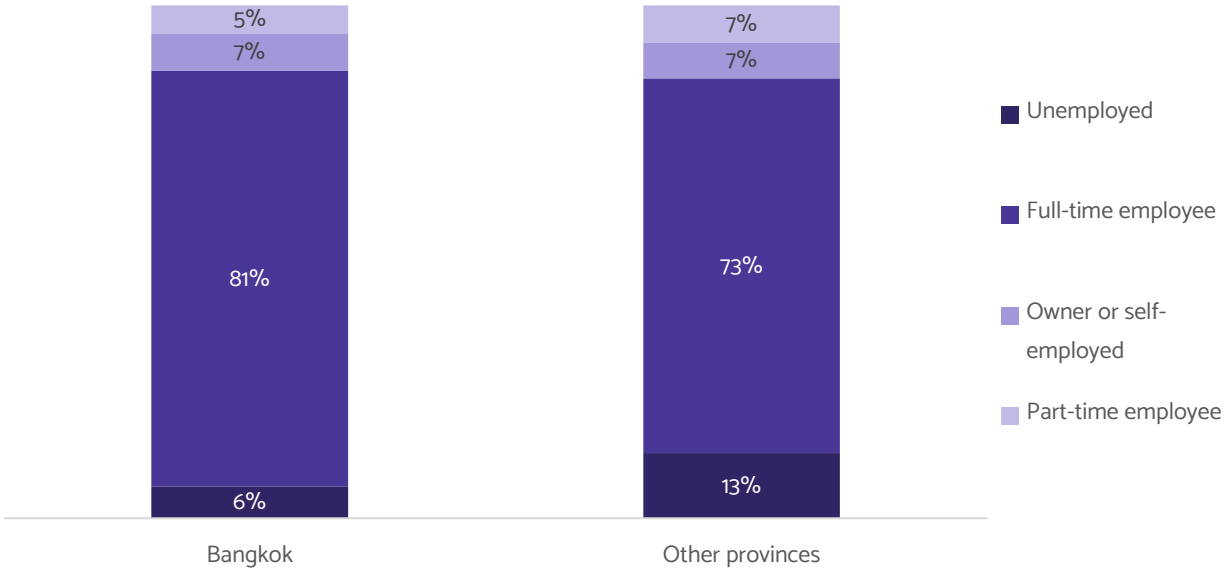
As mentioned previously, marked differences exist between Bangkok and non-Bangkok supply and demand digital economy indicators, such as infrastructure and connectivity, e-commerce readiness, and skills availability. This disparity is also reflected in average salaries; the average monthly income in Bangkok is the highest in the country and more than three times the Northeastern Region (Statista, 2023). Moreover, a subset of the unemployed individuals outside Bangkok may be actively applying for job opportunities in the capital.

Table 2. Employment status of Thai developers

Employment status	Percentage
Full-time employee	78.2%
Owner or self-employed	7.2%
Part-time employee	6.1%
Unemployed	8.5%

Source: own elaboration

Figure 8. Employment status based on region of residence



Source: own elaboration

5.2. Benefits of working in startups and multinational companies

The data collection also attempted to capture the differences between working in specific spaces, such as startups and multinational companies. Out of the total respondents, 24 percent reported working in a multinational company and 17 percent in a startup.

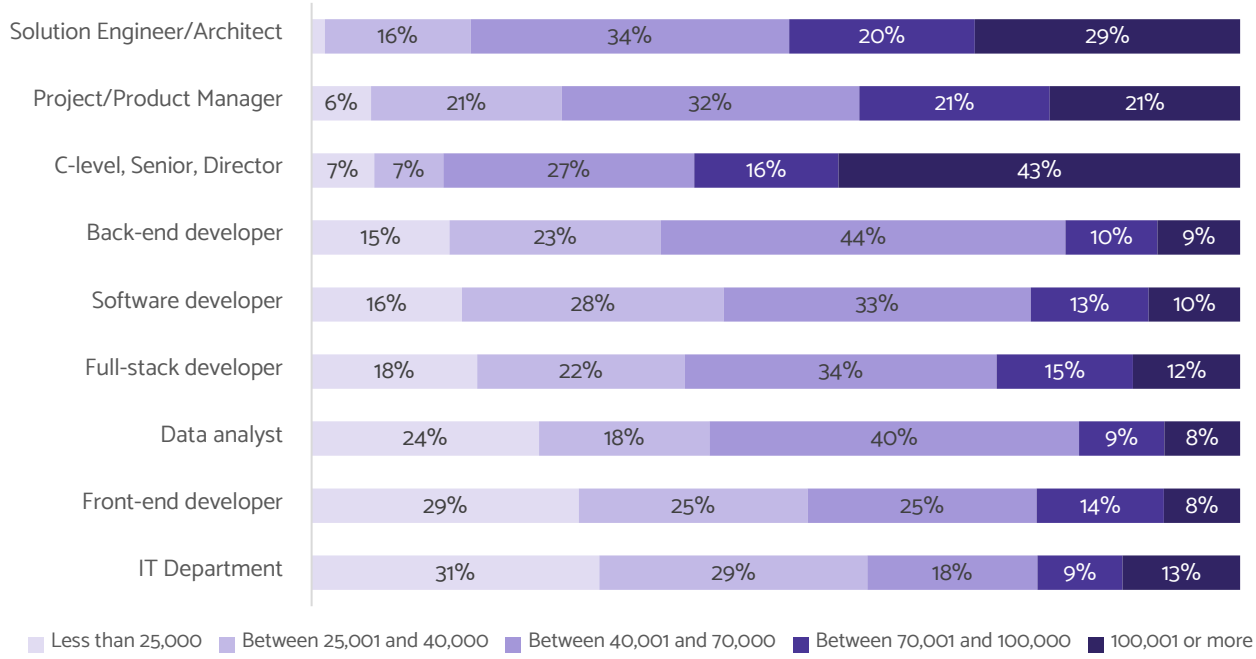
Working from home is more likely to happen when working for a startup or a multinational company. While 41 percent of developers work on average four or more days at home, this share increases to 51 and 48 percent when working at a startup or a multinational company, respectively. In addition, being on the upper side of the income distribution is more likely to work for a multinational company; while 14 percent of Thai developers perceive monthly THB 100,000 or more, this share increases to 26 percent for multinational employees.

5.3. Income of Thai developers: differences by occupation

The questionnaire incorporated a section on position and remuneration levels. The results were grouped for simplification purposes, and the nine positions described in Figure 9 represent those categories with more than 3 percent of the sample. The cumulative sample of Figure 9 corresponds to 75 percent of the remunerated respondents (i.e., who did not declare being unemployed).

The results in the upper end of the income distribution, with higher salaries, are consistent with other developer surveys, such as Stack Overflow (2023), denoting that C-level, solution engineers, and managers are more likely to receive the top salaries of the distribution (THB 70,000+). On the other hand, 60 percent of those working in the IT department receive a monthly income of THB 40,000 or less.

Figure 9. Income groups among most recurring positions (in THB)



Source: own elaboration

** Results only consider non-unemployed respondents*

Data analyst considers data science, data analytics, and business analytics.

IT Department considers IT Asset Management, IT Auditor, IT Director, IT Manager, IT Security, and IT Support

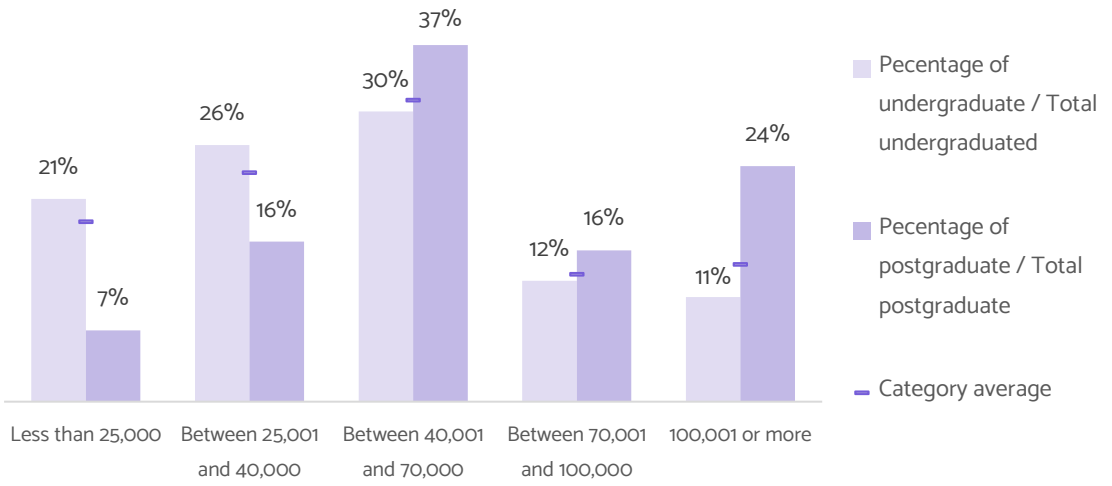
Software developer considers mobile and software developer

6. Income levels

6.1. Income by education level

Results of the survey provide further evidence of the benefits of pursuing postgraduate studies in terms of remuneration. While 40 percent of developers with a postgraduate degree receive THB 70,000 or more (with a majority of this subgroup in the range of THB 100,000+), only 23 percent of developers with a graduate degree are in this category (see Figure 10).

Figure 10. Income group by education level (in THB)



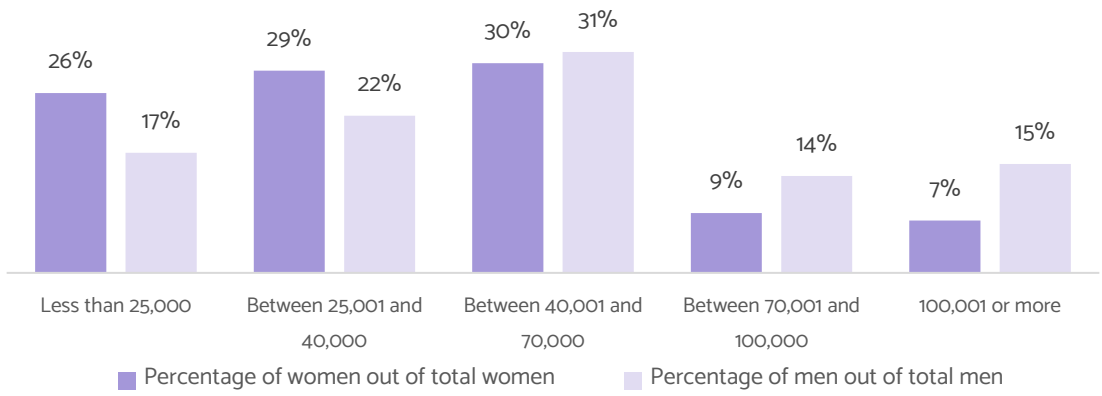
Source: own elaboration

6.2. Gender-income divide

The results of this study align with other surveys and findings in this area, showing that women developers are more likely than men to be in the lower income tier of THB 25,000/month (26 percent compared to 17 percent, respectively) and less likely to be in the top tier of THB 100,000+/month (7 and 15 percent, respectively). Given that the data collection captured an overview of Thai developers, and not their specific tasks and responsibilities at their workplace, it is not possible to conclude gender disparities in salaries (i.e., different remuneration by gender, everything else equal). The differences in income shown in these results could also be attributed to structural factors impeding women and further barriers to their career progress[8].

[8] A suggested approach to advance women in STEM careers is by addressing both internal and external barriers that were reinforced throughout the women's career, for example, by adopting strategies to 1) create safe spaces for women in STEM to discuss their needs, 2) helping women build confidence in their abilities and vision for their career trajectories, 3) making STEM affordable, approachable, and accessible to women, 4) facilitating mentorship, sponsorship, and network building, 5) raising the visibility of women in STEM and creating role models, and) supporting inclusive leadership and institutional change to make STEM fields more open to women (The Asia Foundation, 2021).

Figure 11. Income group by gender (in THB)

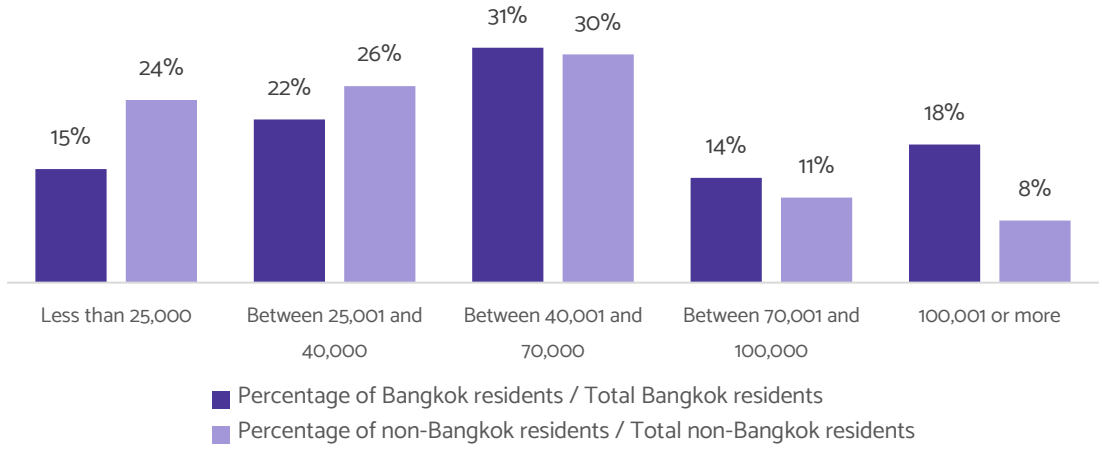


Source: own elaboration

6.3. The Bangkok / non-Bangkok divide

The regional differences between being a Thai developer in Bangkok vis-à-vis other parts of the country are also reflected in salary differentials. Figure 12 shows that while 18 percent of respondents living in Bangkok perceive salaries of THB 100,000 or more, this share is only 8 percent for those living in provinces. Conversely, a higher percentage of developers living in the provinces received salaries of under THB 25,000 (24 percent versus 15 percent for those living in Bangkok).

Figure 12. Income group by region of residence (in THB)



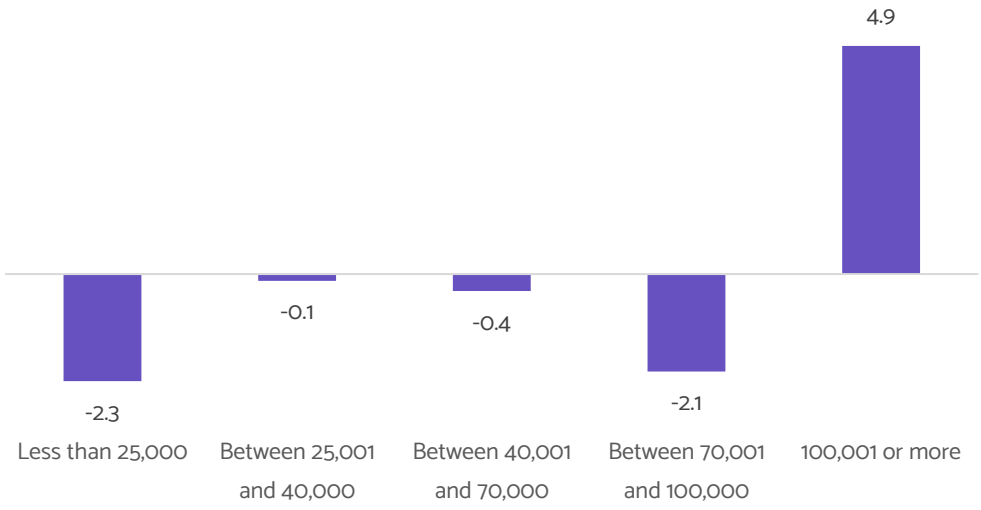
Source: own elaboration

Among the coders living in Bangkok, there are also differences in income for those born in Bangkok compared to those born in provinces. Figure 13 shows the prevalence within income groups between

Bangkok residents born in the capital compared to those born in the provinces[9]. The data suggests the highest differences are for the highest income group (THB 100,000 or more), where developers born in Bangkok are nearly five percentage points more likely to be in that income group category compared to those born in provinces, despite that both groups have the commonality of being current residents in Bangkok.

These results can shed light on the prevalence of market frictions for accessing the best-remunerated jobs in the industry. Using social networks to access job opportunities, such as being referred by family members or friends, can be one cause of wage inequality (Dawid & Gemkow, 2014). In the case of the Thai developer's job market, there is only anecdotal evidence that some of the most appealing jobs tend not to be posted on job-matching social media, but this issue requires further research to be conclusive.

Figure 13. Differences in income groups among Bangkok residents (born in Bangkok compared to those born in provinces), in percentage points



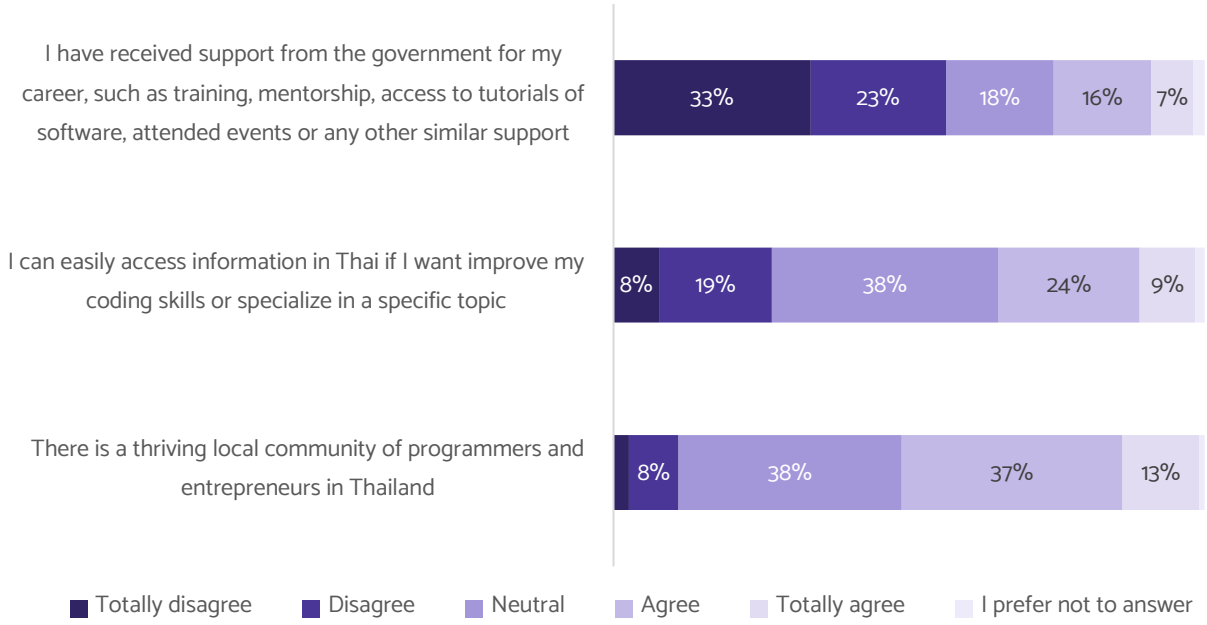
Source: own elaboration

[9] Figure 13 results show the percentage points of difference between Bangkok residents born in Bangkok within a specific income group compared to Bangkok residents born in provinces within the same income group.

7. Perception of Thai Developers

Lastly, this survey provides insights into the programmer's career trajectory and the Thai ecosystem. Figure 14 shows that most respondents (55 percent) did not receive any direct government support, such as training, mentorship programs, or tutorials through earlier stages of their careers. In addition, access to technical Thai language resources is highlighted as a difficulty by 27 percent of respondents. Despite this, there seems to be general satisfaction with the Thai programmer and entrepreneurship community. Figure 14 also shows that 50 percent of developers agree that there is a thriving community, and only 11 percent disagree or totally disagree.

Figure 14. Perception of Thai developers in key issues



Source: own elaboration

8. Key findings and lessons

This study presents the results of the Thai Developers Survey, conducted between December 2022 and March 2023, gathering demographic, skills, and job market information from 1,865 members of the Thai Programmers Association. This analysis aims to gather information to map Thai developers' skills, job market participation, potential income divides, and perceptions of key policy issues. The key findings can be summarized as follows:

1. **The median Thai developer has an undergraduate degree and intermediate English language knowledge.** Only 4 percent of Thai developers completed Matthayon (secondary education) without pursuing tertiary education. Roughly 70 percent of Thai developers possess an undergraduate degree, and 25 percent studied at the postgraduate level. Nearly all report some level of English language knowledge, 17 percent declared having a basic level, 60 percent of respondents had an intermediate level, and 22 percent had an advanced or working proficiency level. Additionally, only 33% of developers stated that they can easily access information in Thai to improve their skills.

2. **The results suggest that a large share of experts in emerging technologies, such as AI, cybersecurity, IoT, and robotics, do not use their expertise in their current role.** Respondents were asked to self-assess their expertise in specific programming languages and technologies. The most common programming languages Thai developers know are SQL, HTML, JavaScript, and Python, which are aligned with the global industry. Respondents who reported some level of expertise with new technologies such as AI, cybersecurity, the Internet of Things, and robotics represented 32 percent of the sample. A portion of these respondents reported that they do not currently work in these field suggesting both an opportunity to tap expertise in these emerging areas and a need to track job opportunities for these skills in local markets.

   It is important to understand job market trends and future needs when designing training programs to bridge skills gaps in emerging technologies. In particular, the hypothesis of underutilization of existing skills in the labor market should be standardized and quantifiable

prior to expanding the supply of local experts. Second, if this hypothesis is proven, the underutilization of experts suggests information asymmetries in the job market (i.e., programmers do not know about job offers aligned with their expertise) or a lack of demand for jobs in these emerging technologies.

3. **Time constraint is the main barrier to upskilling.** Most respondents (54 percent) declared that they did not have enough free time to upgrade or acquire new skills. These results are aligned with other sources and suggest that the tradeoff for upskilling is between working hours and training, and not between training courses and free time (e.g., after work hours or weekends).

   Hence, there is room for collaboration among employers, the public sector, and trainers to create mechanisms to overcome this barrier. The Thai government currently offers tax incentives to encourage employee development, offering a 150 percent deduction if workers are enrolled in certified training courses (KPMG, 2023). However, these efforts would benefit from addressing the tradeoff described above, for example, by requiring the training to occur totally or partially during working hours.

4. **Women's participation and access to higher-paid jobs are still a challenge.** This study shows evidence that the presence of women among programmers is lower than in other comparable occupations. While women represent 28.4 percent of science and engineering and 26.6 percent of ICT professionals in Thailand, women's developers are 16.7 percent of the total. Moreover, women's participation as a share of total developers remains relatively constant across age ranges. In addition, women developers' are highly skewed toward lower salary tiers than that of men.

5. **Most programmers born in provinces migrate to Bangkok, and Bangkok-based developers are more likely to have the highest-paid jobs compared to those living outside of Bangkok.** This survey shows that nearly 60 percent of Thai developers were born in the provinces, but 65 percent live in Bangkok, suggesting internal migration to the capital and the subsequent "brain drain" in the provinces.

In addition, the survey's data shows that developers residing in Bangkok are more likely to have jobs in the higher-income tiers. This gap also applies to developers living in Bangkok who were born there vis à vis internal migrants. A quasi-experimental analysis is needed to test whether these differences are explained by the prevalence of frictions in the job market such as using social networks (e.g., family members and friends) to access high-paid jobs. In addition, the share of unemployed Thai developers in the provinces is more than double that of Bangkok.

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