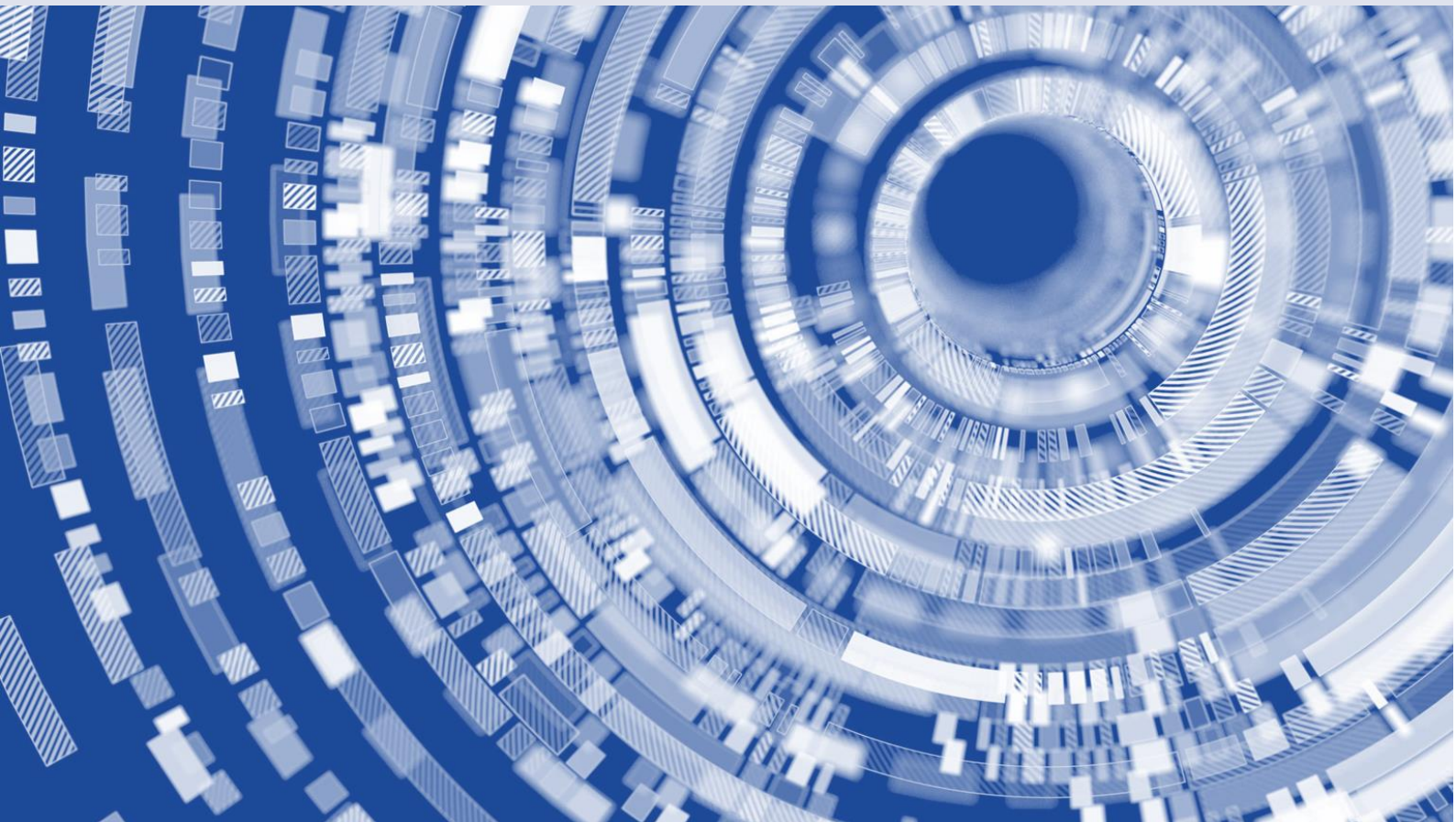
Policy Proposal for a Labor Market Common Language

Skill-based language and reforms address impacts of generative AI

Mitsubishi Research Institute, Inc.
in collaboration with Lightcast

Mitsubishi Research Institute × Lightcast



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Preface

Japan's labor market is undergoing a significant and pivotal transformation. On the supply side, the labor force is shrinking at an alarming rate, spurring a decline in the number of workers in the coming years. Conversely, on the demand side, the shift in industrial structure driven by the need for decarbonization and economic security, coupled with the introduction and widespread adoption of transformative technologies like generative AI, will likely bring about fundamental change in the skills required of the workforce. These pressures are challenging the traditional Japanese employment system, characterized by mass recruitment of new graduates, seniority-based compensation, and lifelong employment and are starting to nudge the workforce toward greater mobility.

The ability of the Japanese employment system to adapt to these changes remains in question. The Kishida administration's *Basic Policies for Economic and Fiscal Management and Reform 2023*, approved by the Cabinet in June, presents a three-pronged approach to labor market reform[1]. These reforms, centered around "supporting skill development through reskilling," "introducing job-based pay aligned with individual company conditions," and "facilitating labor mobility towards growth sectors," aim to make the rigid Japanese labor market more flexible. The goal is to stimulate an increase in wages, growth of the economy, and movement of human resources within and outside companies towards sectors with future potential. We see policy to promote skill development, encouraging career transitions to growth fields, and rewarding learning and action with higher wages as a step in the right direction to address the emerging changes in the labor market.

However, there is one element that is missing in the reform package: the need for adequate information for workers and companies to make informed decisions. All actors need information regarding workers' skills, the desired qualifications sought by companies, the necessary learning paths to acquire new skills, and the rewards associated with skill acquisition. Unfortunately, in the case of Japan, such information yet lacks uniform distribution in a common language accessible to all.

Mitsubishi Research Institute (MRI) has proposed in its policy recommendations the importance of establishing a FLAP cycle—Find, Learn, Act, and Perform—to revitalize Japan's labor landscape[2]. While the current policy framework addresses the aspects of reskilling, or Learn, smooth labor mobility, or Act, and the introduction of job-based pay, or Perform, it lacks a fundamental approach, and a comprehensive set of measures, toward Find, which forms the starting point of the FLAP cycle. Without proper distribution of relevant information, workers may struggle to identify growth opportunities, and even if they do manage to navigate toward such areas, it could lead to mismatch and lower wages, undermining the intended objectives of the reforms.

The purpose of this report is to propose a systematic approach to establish a common language within the Japanese labor market. Our conclusion is that promoting human resource mobility in Japan requires a combination of skill assessment and disclosure of company's shared values.

These conclusions are founded in a fundamental perspective on the changes to occur in the labor market over the next 15 years, based on calculations regarding the projected labor supply and demand in Japan. We have also outlined a framework for information disclosure that encompasses both shared values and skill assessment. We provide a concrete vision of how human resources can be assessed, with a specific focus on skills. Our quantitative analysis of skill assessment relies on the skill taxonomy developed by Lightcast, with whom we collaborated on this report. Their skills data, which is derived from online job postings in the US, Europe, and Asia, has potential to serve as a common language linking domestic and international labor markets. Furthermore, this report presents case studies of human resource development in the semiconductor and offshore wind power sectors—two of Japan's critical areas—and offers policy recommendations based on the implications drawn from these findings.

Chapter 1
Forecasting the Labor Market in 2035
- Expanding Gaps, Skill Mismatch and Task Substitution

- Labor supply is on the decline and will be insufficient for the demand presented by DX and GX.
- The skills mismatch, affecting 4.8M workers, is even more pressing.
- Generative AI will take over non-routine tasks, making one's command of AI tools paramount.

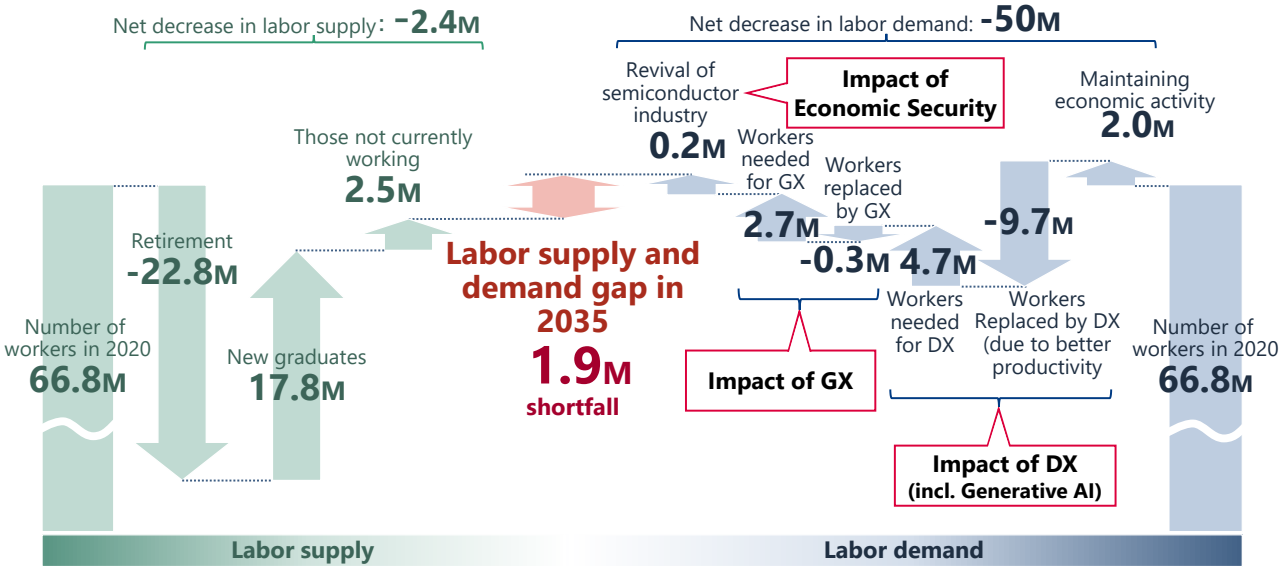
Our assessment starts with a forecast and analysis of how the labor market will change over a 15-year period from 2020 to 2035, taking a close look at the gap, or difference, between labor supply and demand. Here, demand is forecast to match Japan's digital transformation (DX), green transformation (GX), and the revival of the semiconductor industry and its support to the domestic market. Supply is projected under a base-case scenario assuming that demographic factors, as well as the employment structure by gender and age, continue following the current patterns.

It is important to note that the outlook for both labor demand and supply is subject to uncertainty. The results presented in this analysis should be regarded as highly probable future projections. These projections, which take into account demographic trends, technological advancements, and changes in human resource requirements projected in the next 15 years, provide insights and suggestions to guide the future.

Labor supply destined to decline under base scenario

Figure 1 illustrates shifts in labor supply and demand due to major factors from 2020 to 2035. The left shows the changes following the base-case scenario. Over the past 25 years, the working-age population, those between ages 15 and 65, has been on a downward trajectory. Despite this

Figure 1: Labor Demand and Supply balance between 2020 to 2035



Note: Each item is rounded to the nearest 100,000.
Source: Mitsubishi Research Institute, Inc.

decline, the Japanese economy has managed to maintain its workforce by increasing employment rates for women and seniors. However, a decrease in the number of workers will be inevitable for the next 15 years.

These changes are driven by three main factors. First, retirement numbers are expected to amount to over 20 million over the next 15 years. Second, the number of new graduates entering the workforce is projected to fall from 1.3 million to 1.1 million per year over the next 15 years due to the declining birthrate.

Third, there is potential for an increase in labor supply through greater participation of women and seniors. Their employment rates saw substantial growth in the 2010s, but sustained growth depends on the success of measures addressing the declining birthrate, work style reforms, and pension system reforms.

We referenced existing literature[3] by the Japan Institute for Labor Policy and Training to set our labor participation growth rate, but we see the overall downward trend in labor supply as something beyond reversible.

DX, GX, and the revitalization of semiconductor industry require people

The right side of Figure 1 shows changes in labor demand, specifically four main factors.

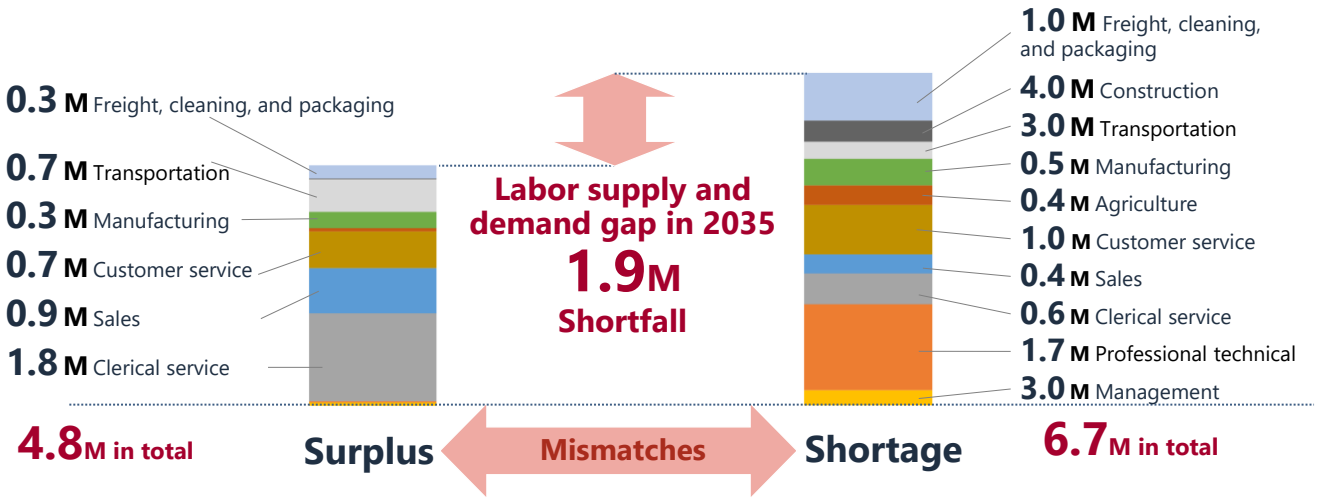
First, sustaining current economic activity under the current demographic conditions will require two million more workers than in 2020. This is posited on minimal real economic growth and labor productivity, and the extra workers will only barely maintain the size of the economy.

However, due to the ongoing decline in labor supply, the economy cannot sustain its size without innovation. This is where DX sweeps in as the second major factor. We estimate that Japan's DX will result in 4.7 million new jobs—this is even after taking into consideration a 9.7 million loss in jobs due to better productivity. Such big shifts will come from expected advancements in digital transformation, with AI, IoE, and robotics as core technologies. Appendix A covers the details of how we calculate this. It is important to note that the analysis also considers the employment impact of generative AI.

Furthermore, the long-term challenges for the Japanese economy include green transformation (GX) to achieve decarbonization and economic security through supply chain reinforcement, especially in the context of escalating issues like the US-China trade conflict and Russia's invasion of Ukraine. We identified labor-demand changes due to carbon neutrality[4] as the third main factor and those due to revitalization of the domestic semiconductor industry, vital for economic security, as the fourth. GX should bring a net increase of 2.4 million job openings and semiconductor revitalization an additional 0.2 million[5].

Substantial labor demand awaits DX, GX, and the revitalization of domestic semiconductor industry,

Figure 2: Labor mismatches by industry and occupations in 2035



Source: Mitsubishi Research Institute, Inc.

but while productivity growth driven by innovation can contribute to economic growth, the constraints posed by the labor supply will continue to be a significant challenge for the Japanese economy.

Skills mismatch poses a more significant challenge than labor shortage

A deeper look at the qualitative aspects of Japan's labor force reveals a more severe situation. Figure 2 provides a detailed breakdown of supply and demand across 170 sectors and 230 occupations. It specifically focuses on identifying areas where sectoral and occupational mismatch occurs, categorizing these as either *surplus* or *shortage*. Mismatch will occur on a scale far exceeding the 1.9 million in labor shortage.

In 2035, 4.8 million jobs will be in surplus, primarily in occupations such as clerical, sales, and customer service work. These occupations often involve tasks that may be replaced by machines as a result of DX. Additionally, occupations related to GX, such as internal combustion engineers and thermal power-plant workers, will experience reduced demand.

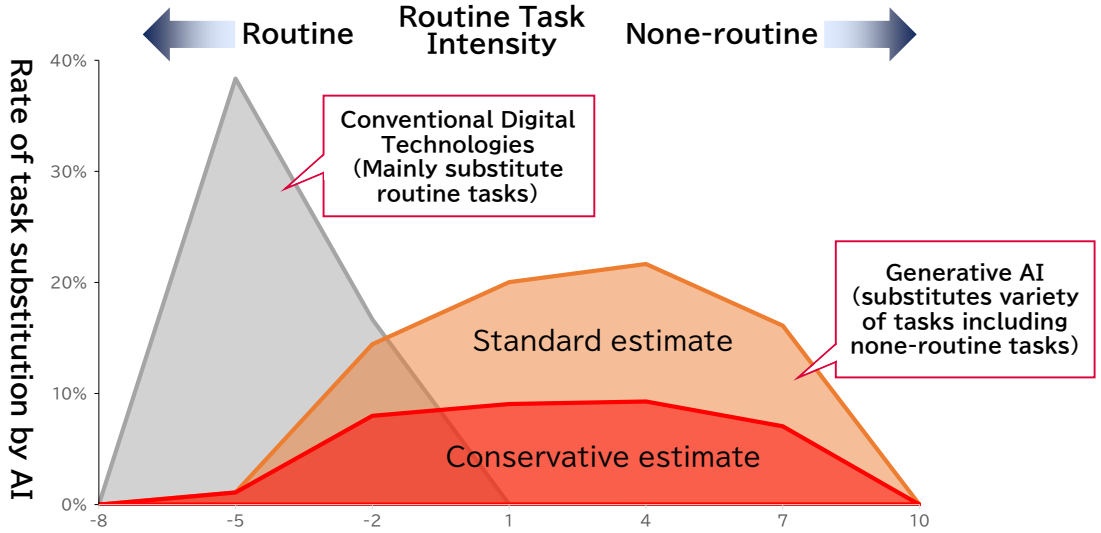
The most acute labor shortage is for professional technical occupations at 1.7 million. Customer service work and jobs related to freight, cleaning, and packaging come in at a close second with 1 million each. These light-duty occupations currently employ a considerable number of senior workers, making it even more crucial to address the impending mass retirement.

Generative AI can replace a wide range of non-routine tasks

While the discussion tends toward counts of jobs and people, the reality is that mismatches occur in terms of tasks within occupations and in terms of skills required to perform those tasks.

The 1.8 million surplus for clerical workers can be interpreted as a situation where approximately 15%, or 1.8 million, of the tasks performed by Japan's overall clerical workforce, which exceeds 12 million, will be automated through digital technologies. The time freed by automation can then be allocated to more advanced tasks through reskilling and upskilling. If these tasks can be aligned with those of the 1.7 million professional technical roles that are lacking on the supply side, Japan will be one step closer to resolving the labor mismatch. The key will be to achieve a gradual shift in the composition of job tasks for clerical workers toward that of professional technical roles—reskilling and upskilling make this possible. Here, the tasks

Figure 3: Scope and rate of task substitution: Traditional digital technologies vs. generative AI



Note 1: As of 2020, conventional digital technologies refer to techniques employing perception AIs such as deep learning. The estimations for task substitution by generative AI follow the methodology outlined in Eloundou, Manning, Mishkin, and Rock (2023).
Note 2: The "conservative estimate" is based on a conservative scenario for the societal implementation of generative AI.
Source: Mitsubishi Research Institute Inc., based on data from the U.S. O*NET labor force survey, census, and other sources

associated with jobs and roles, as well as the skills required for them, will evolve rapidly and continuously.

Furthermore, the advent of generative AI systems like ChatGPT has redefined the tasks that digital technologies can substitute, thereby altering the employment landscape. Historically, digital technologies have been regarded primarily as substitutes for routine work. However, upon evaluating tasks that generative AI can potentially replace, based on certain conditions, it became evident that the scope extends to non-routine tasks, which were traditionally thought resistant to automation (Box 1 presents a detailed explanation). Figure 3 collates the range and substitution rates of tasks that can be automated, categorized by their level of routine-ness. As is evident, compared to traditional digital technologies, generative AI possesses the capacity to substitute a broader swath of 'non-routine tasks.'

We went on to examine how this affects employment. Assuming a 50% replacement rate for replaceable tasks, the estimated impact on employment is equivalent to 4.6 million jobs. In addition, when accounting for tasks substitutable by conventional AI and other digital technologies, the overall impact is estimated to be 9.7 million people, or more than 15% of Japan's total workforce in 2035.

Mobility and skill change are driving the labor market

Using this analysis as a springboard, we considered the future of Japan's labor market from three perspectives: labor shortage, skill mismatch, and task replacement.

First, the mobility of the labor market, encompassing the movement of workers across firms and industries, is indispensable for addressing mismatch beyond 10% of the workforce. The imperative for Japan to achieve GX and to ensure its economic security has only boosted the prominence of the labor mobility issue. The reason for this is the breadth of what needs to be done: economic security will require, for example, revitalizing the semiconductor industry, and GX spans the transition to renewable energy sources as well as the shift from internal combustion engines to electric vehicles (EVs).

Against this backdrop, companies aiming to expand their presence in growth areas must effectively communicate exactly what they require of the human resources they seek. This entails providing comprehensive information about the company's shared values, objectives, and management strategies in a manner that can be readily understood by job seekers from diverse industries. Additionally, individuals employed in mature sectors must be able to assess their own skills and work experience, envision their capabilities, and proactively acquire the necessary skills to participate in growth areas. In both cases, information must be communicated in a common language that is accepted in the labor market beyond the boundaries of individual companies.

The second implication is that the skills required of humans will undergo more disruptive changes than ever before due to the advancement of generative AI, leading to the replacement of jobs, including tasks previously considered none-routine. Tasks like explaining medical information to a patient or creating art materials based on a specific concept, which were traditionally considered fundamental to certain professions, are now being performed with reasonable accuracy by AI models such as ChatGPT and image generation AI. Moreover, these AI models are continuously improving their accuracy over time. Such tools have the potential to surpass human capabilities by several orders of magnitude.

In a world where humans collaborate with AI, the focus will shift from what specific job one holds to what skills one possesses to accomplish the required tasks. Furthermore, the skills performed by humans and the skills required to effectively utilize AI will continue to change dramatically. This will uproot the traditional notion that skills improve with seniority. Instead, it will become essential to grasp the skills possessed by workers at in detail and constantly reassess how the combination of human skills and AI can enable work to be performed efficiently and creatively.

Future labor market reforms should consider human resource mobility and skill change. However, it remains to be seen whether the Japanese labor market is sufficiently prepared for these changes. The next chapter will delve into this question by shedding light on the state of information disclosure in the labor market.

BOX1: How Generative AI Will Transform Work

- Estimating employment impacts using occupational data and ChatGPT -

Assessing employment impact based on task substitutability:

The employment implications of generative AI models, led by the likes of ChatGPT, surpass the bounds of conventional AI predicated on deep learning. Ascertaining the full measure of these effects on our occupations is elusive at this juncture. Yet, drawing on the methodology outlined in the joint paper by OpenAI and the University of Pennsylvania, titled "GPTs are GPTs: An Early Look at the Labor Market Impact Potential of LLMs" (Eloundou, Manning, Mishkin & Rock, 2023), we ventured into an analysis of Japan's potential employment substitution.

We analyzed the U.S. occupational database O*NET, which defines over 2,000 Detailed Work Activities (DWAs). Our mission was to discern whether each DWA could be replaced by generative AI alone or with added applications. For DWAs deemed replaceable, we projected a 50% reduction in the time required to accomplish the activity. Grounded in Japan's 2020 employment composition, we then quantified the employment impact in terms of equivalent personnel. To assess the AI's substitutability, we applied the rubric described in the aforementioned paper, employing GPT3.5 for automated assessments (Figure 4). Given ChatGPT's inherent variability with standard parameters, we conducted ten assessments, leveraging their outcomes to pinpoint the replaceable DWAs.

We used two ways to gauge the employment impact: a standard estimation based on the mean of the ten assessments and a conservative approach that deemed any DWA rated as non-substitutable, even once, as irreplaceable. The standard estimation resulted in 9.3 million and the conservative approach 4.6 million. We used the results from the conservative approach for our projections in Chapter 1. We do so acknowledging that the broader deployment of generative AI in society will encompass not only technical considerations but also legal frameworks like copyrights and social sentiments, including employment apprehensions. While cautionary voices urge restraint in embracing generative AI, as the discourse evolves, employment impacts could amplify to the levels indicated by the standard estimation.

Figure 4: Assessment results of detailed work activity (DWA) substitutability by Generative AI

Trial No.	E0	E1	E2	E3	E1-E3	ERROR	Total	E0	E1	E2	E3	E1-E3	ERROR	Total
1	1,421	381	267	13	661	5	2,087	68%	18%	13%	1%	32%	0%	100%
2	1,430	371	268	14	653	4	2,087	69%	18%	13%	1%	31%	0%	100%
3	1,396	397	271	20	688	3	2,087	67%	19%	13%	1%	33%	0%	100%
4	1,443	384	248	11	643	1	2,087	69%	18%	12%	1%	31%	0%	100%
5	1,434	384	255	13	652	1	2,087	69%	18%	12%	1%	31%	0%	100%
6	1,402	396	276	10	682	3	2,087	67%	19%	13%	0%	33%	0%	100%
7	1,399	419	248	16	683	5	2,087	67%	20%	12%	1%	33%	0%	100%
8	1,437	386	243	19	648	2	2,087	69%	18%	12%	1%	31%	0%	100%
9	1,416	387	264	16	667	4	2,087	68%	19%	13%	1%	32%	0%	100%
10	1,391	402	273	16	691	5	2,087	67%	19%	13%	1%	33%	0%	100%
Conservative Estimate	1,824	–	–	–	263	–	2,087	87%	–	–	–	13%	–	100%

Note 1: GPT-3.5 was used for assessing the potential for task substitution. E0: activities that cannot be substituted by generative AI; E1: activities that can be substituted by generative AI alone; E2: activities that can be substituted through applications equipped with generative AI; E3: activities that can be substituted through systems capable of capturing or generating images.

Note 2: Under the conservative estimate, tasks are categorized as E0 if they received an E0 judgment even once over the course of ten trials.

Source: Mitsubishi Research Institute, Inc.

Generative AI has the potential to subsume even non-routine tasks

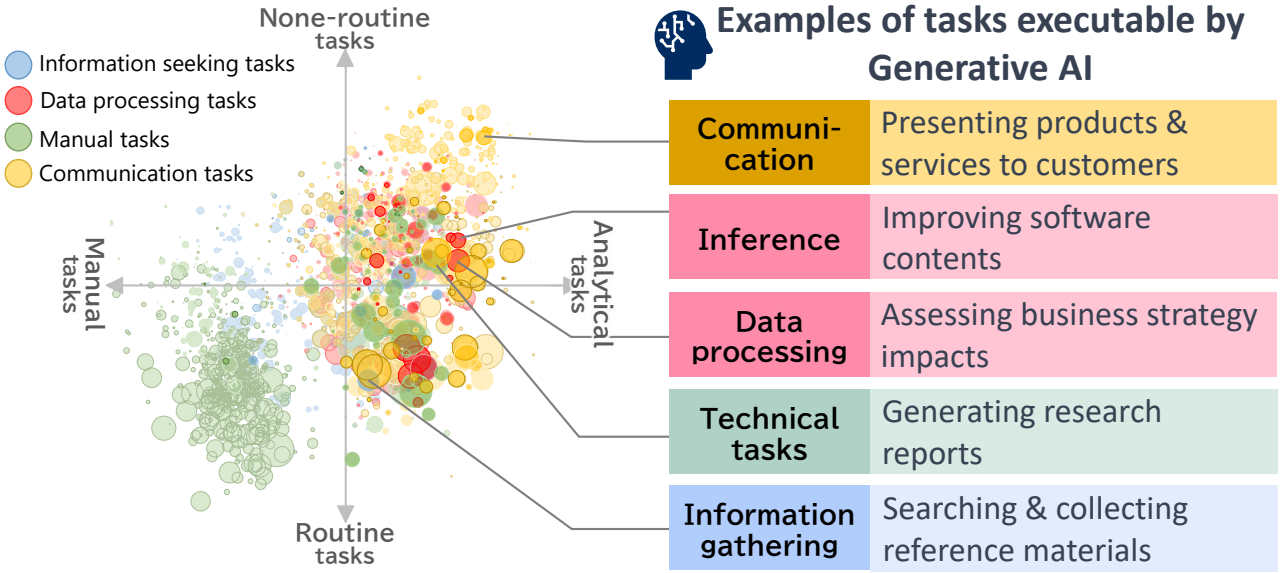
To further assess DWAs deemed replaceable by generative AI, we used a job-characteristic based Japanese talent portfolio, a framework we have worked in recent years[6] (Figure 5).

Historical precedents of digital technology adoption largely envisioned the replacement of human labor with routine tasks, as symbolized by the bottom section of the diagram. Yet, our present analysis reveals that generative AI could supplant even those tasks traditionally regarded as non-routine.

In Figure 5, darker circles signify DWAs that are replaceable based on our conservative estimation. Although there is a marked concentration in analytical tasks, which don't involve physical work, the results also strikingly point to tasks historically regarded as uniquely human. These comprise communication-focused tasks (yellow bubbles) and data-processing tasks (red bubbles), many of which entail nuanced inference.

Moreover, among the replaceable DWAs are tasks such as "advising others on analytical techniques", "counselling on health and safety issues", "crafting guidelines for system implementation", and "analyzing the repercussions of regulatory changes". The presence of these tasks—integral to specialist and managerial roles—offers profound insight. Conversations around AI-induced employment displacement frequently betray an anxiety that AI might usurp human roles wholesale. However, the swath of tasks generative AI is poised to replace are not necessarily those that complete jobs in and of themselves but rather bolster human efficiency and augment quality. Since the advent of generative AI, digital transformation should be understood to transcend the replacement of mundane tasks and that it can serve as a creative ally, redefining how work is done across the spectrum of professions.

Figure 5: Japan's 2020 task portfolio and tasks susceptible to substitution by Generative AI



Note: The tasks that generative AI can perform have been determined using the methodology of Eloundou, Manning, Mishkin and Rock (2023).
Source: Mitsubishi Research Institute Inc. based on data from the U.S. O*NET, Census, and labor force surveys

Chapter 2
Information Disclosure in Japan's Labor Market: Needs shared values and skill assessment

- Government reforms fail to establish a common language for the labor market.
- US and European corporations aim to be skill-based organizations by assessing their workforce in terms of skills.
- Information disclosure for job-based human-resource management should be follow the principles of shared values and skill assessment.

Japan is ill-prepared to effectively mobilize its workforce

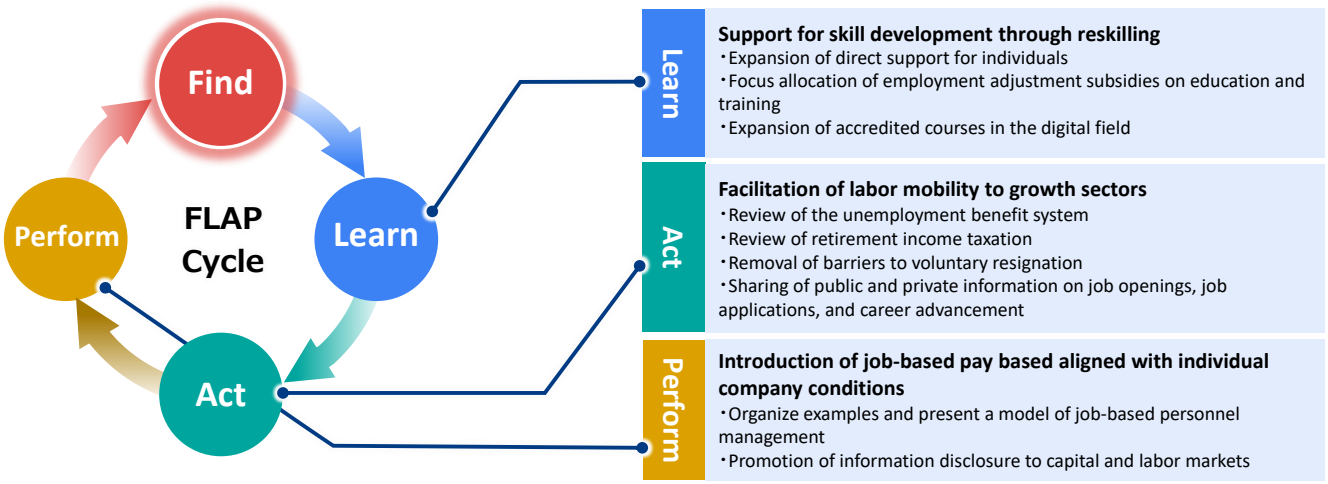
Forecasts for labor supply and demand through 2035 and the disruptive changes in required skills that await cast doubt on whether the current Japanese labor market is adequately prepared. We propose a four-stage cycle—Find, Learn, Act, and Perform (FLAP)— as a key strategy for revitalizing Japan's labor market. In detail:

1. Find: Accurate assessment of the company's HR requirements, skills and experience of the workforce, and the gap between the two
2. Learn: Workers acquire the necessary skills through reskilling and upskilling to adapt to evolving demands in growth areas
3. Act: Workers explore new opportunities and make strategic career moves aligned with their skills and market demand
4. Perform: Workers become active in the workforce with compensation that aligns with the acquired skills

Smooth execution of the cycle is crucial for promoting human resource mobility. However, in Japan's labor market, there are inadequacies in the legal system, labor practices, and infrastructure that pose significant barriers and obstacles at each step of the cycle.

In an effort to better the situation, the Kishida administration gained approval via cabinet decision for its high-profile policy, the *Basic Policies for Economic and Fiscal Management and Reform 2023*. It features a three-pronged approach to labor market reform with each corresponding to a different phase of the FLAP cycle: support for skill development through reskilling as Learn, facilitation

Figure 6: FLAP Cycle and Kishida Cabinet's Three-pronged Labor Market Reform



Source: Mitsubishi Research Institute, Inc.

of labor mobility to growth sectors as Act, and introduction of job-based pay aligned with individual company conditions as Perform (Figure 6).
However, current policy lacks the Find aspect, in other words the disclosure of information. This aspect is essential for enabling appropriate labor mobility.

Government guidelines lack a common language

Government guidelines do refer to information disclosure, addressing its importance with measures in each pillar. They describe the required information, methods for sharing information, and specific information systems (Figure 7). However, they fail to establish a common language for sharing various types of information among different participants in the labor market, essential for workforce mobility.

Companies, employees, job seekers, and educational institutions need a common way to communicate. For instance, how will career consultants access and utilize the information regarding open badges (digital credentials)[7]? How can companies utilize Job Tag, the Japanese version of O-NET, to develop job descriptions and define skill requirements? How will the findings from the analysis of job training's impact on compensation improvements be effectively integrated into companies' learning and development strategies?

With the increasing mobility of the workforce, the FLAP cycle extends beyond internal human resource activities to include external labor and education markets. To ensure seamless collaboration, this cycle should be supported by a widely adopted, regularly updated, machine-readable, application-independent, and open-sourced common language. However, the reform guidelines fail to address the fundamental concept of such a common language.

Designing job-based pay and personnel management

Information disclosure also plays a crucial role in job-based pay and personnel management, key components of the government reforms.

Recognizing the inevitability of human resource mobility, the reform guidelines emphasize the importance of companies clearly indicating the salary levels that correspond to specific job responsibilities. Such information encourages workers to continually learn and take proactive actions. While the guidelines acknowledge the need for a gradual and adaptable implementation process to accommodate small and medium-sized enterprises (SMEs), their core objective of urging companies to prepare for greater labor mobility remains sound and clear.

However, it is essential to consider the potential drawbacks of placing excessive emphasis on the job-based approach. As job descriptions become increasingly detailed, there is a risk that they may become less comprehensible to job seekers from outside the company, reducing their effectiveness as a common language. Furthermore, the spread of new digital technologies has led to a swift evolution in the skills necessary to perform job tasks, and consequently, there will be a greater disparity in the

Figure 7: Excerpts from the disclosure and sharing of information in the Guidelines for Three-pronged Labor Market Reform

Learn — Support for skill development by reskilling

- Authenticate and display **credentials digitally (e.g. open badge)**
- Identify areas of high wages and high employment potential
- **Validation of reskilling content**
- Measurement and analysis of the **effect on compensation, internal and external promotions and appointments after the course**

Act — Facilitation of labor mobility to growth sectors

- Process and consolidate information held in public employment services (e.g. Hello Work) regarding **job openings and job applicants** and private human resource companies' information on **number of job openings, wages, and required skills** by job type, region and share it with career consultant.
- Enhance and promote the use of the workplace information site **Shokubalabo**
- Enhance and improve convenience of **Job Tag**, the Japanese version of O-NET

Perform — Introduction of job-based pay based aligned with individual company conditions

- **Information disclosure** of salary and employment systems to **the capital and labor markets**
- Visualization of the job descriptions and required skills as well as qualification, experience, career aspirations of job seekers, and **match them against job descriptions**.
- Adjust **standardized job definitions** held by global human resources consulting firms

Source: Mitsubishi Research Institute, Inc.

performance of job tasks depending on the skills acquired by workers. As a result, the connection between job descriptions, productivity, and wages becomes increasingly unstable.

Furthermore, placing excessive emphasis on job descriptions may cause workers to detach themselves from the shared values and purpose of the company, potentially diminishing their engagement and interest in tasks that fall outside the confines of their job descriptions.

Skill-based organization: an approach gaining steam in the US and Europe

The US and Europe have long relied on a job-based approach, and discourse in these regions has begun to scrutinize the inherent drawbacks. Some companies have adopted a whole-person approach to addressing their employees; they are viewed as people with diverse skills and abilities, not just job titles or roles. And building on this is the notion of a skill-based organization, wherein human resource policies are based on the individual skills of workers.

The concept of skill-based organizations has been triggered by the publication of proposals and studies from international organizations such as the OECD and the World Economic Forum (WEF). These authorities have called for reskilling in light of the rapid spread of AI and other digital technologies on employment. For example, the "Reskilling Revolution" initiative, launched by the WEF at its 50th annual meeting in 2020, is a joint effort by O*NET in the US, ESCO in Europe, and several HR firms, known as SkillTech, to develop a common global skills system[8].

In light of these developments, several global companies, supported by government and international organizations, have taken steps toward becoming skill-based organizations. Figure 8 showcases a collection of specific examples derived from the World Economic Forum's May 2023 publication *Putting Skills First: A Framework for Action*[9]. These examples of skill-based measures do not entirely abandon the traditional job-based employment framework. Instead, they involve mapping skills to existing jobs and roles, benchmarking skills against competitors, and leveraging external education and training programs for reskilling and upskilling.

The information disclosure required for job-based HR in Japan

Japan will require a specific form of information disclosure to effectively support job-based human-resource management (Figure 9). First, corporations must broaden the understanding of their jobs, values, objectives, and strategies through dialogue with employees and job seekers. Second, they must accurately assess the diverse skills of employees and assign jobs and roles based on those skills.

Figure 8: Measures of companies working to become skill-based organizations

Name of company or institution	Examples of skill-based measures
Unilever	Actively working on building a future-fit workforce by increasingly focusing on skills instead of job titles.Started with 600 Unilever-endorsed skills based on Degreed's skills taxonomy and utilized Degreed as the central learning hub for all office-based workers.
HSBC	Introduced an in-house skills insight hub using WEF's skills taxonomy. Maps internal jobs and roles against skills of taxonomies, compares them with data from other companies to understand skills supply and demand in the industry.
Siemens	Provides lifelong learning and development, upskilling, and reskilling for over 300,000 employees. Leverages My Skills, a distributed skills support tool, to provide learning opportunities in more than 130,000 different fields.
European Commission (EC)	Adopted a proposal to make 2023 the "Year of Skills" in order to boost skills recognition throughout EU member states. Aims to have at least 60% of adults in training every year and at least 78% employed by 2030.
Skills Future Singapore	All citizens over the age of 25 receive a credit of SNG $500 and are also eligible to take upskilling courses offered by universities, private vocational schools, and other institutions. Training participation increased from 35% in 2015 to 50% in 2021.

Source: Mitsubishi Research Institute, Inc.

(1) Disclosing shared values

To meet the growing demand for human capital management, which involves investing in personnel to enhance corporate value, large companies led disclosure about their human resources to the capital market in the fiscal year ending on March 31, 2023. However, disclosure must be extended beyond capital markets to reach the labor market.

Disclosure to the labor market will serve as a valuable tool for companies to recruit, develop, and communicate with human resources. It will also drive the transformation of labor practices. In the face of changes to employment structure, compensation, and working conditions, it is crucial to obtain understanding and support from both internal and external stakeholders including employees, job applicants, and employees of other companies. If a company fails to articulate the alignment of its human resource and overall business strategies in a common language, it risks being glossed over by potential human resources.

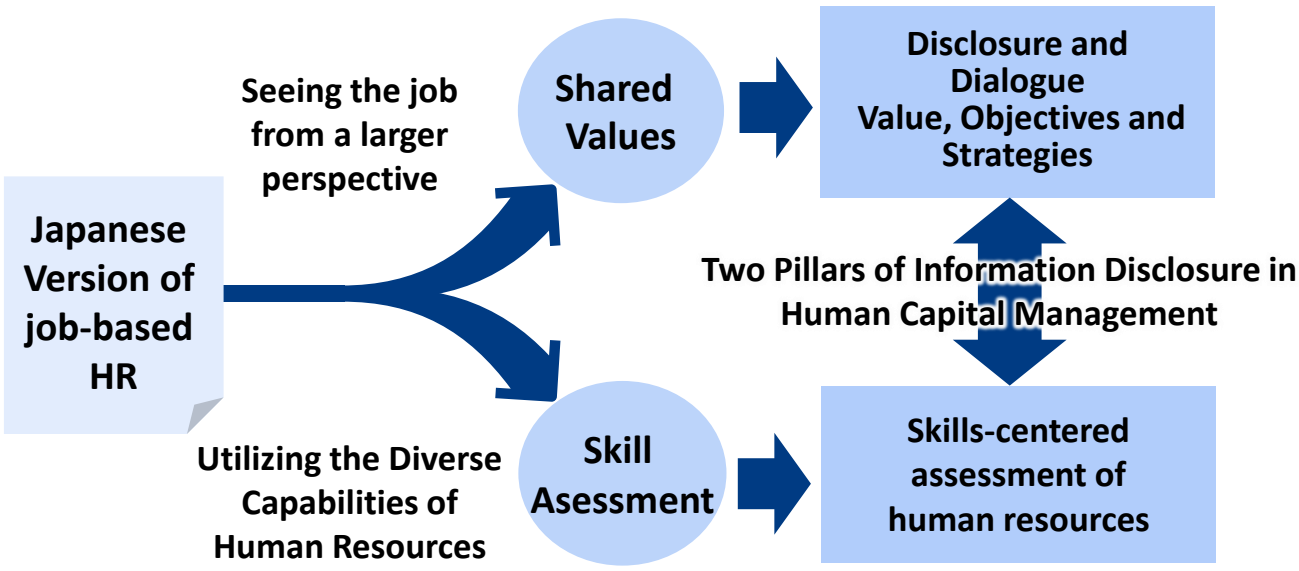
(2) Skill assessment

Corporations around the world are starting to assess their human resource portfolios through visualizations of skill data using a standardized skill framework. The objective is for companies to effectively use visualizations of data on the specific skills they seek while enabling employees to understand their own aptitudes and identify the direction they should take in their reskilling. This approach empowers organizations to harness the full potential of the diverse skill sets possessed by their workforce. In contrast to a rigid job-based employment structure that confines employees to predefined roles, it aims to address personnel mismatch by using skills as a key indicator.

Naturally, an abrupt transition to a skill-based system presents its own challenges. Therefore, it is best to begin with business units that have easily definable skills or operate on a project basis, gradually expanding the system company-wide. Furthermore, while skill-based measures are geared toward skill development and mid-career hiring, it proves difficult to incorporate them into compensational structures. Businesses should start with measures that are easy to implement while promoting systematic visualization of skills data.

In the next chapter, we will delve into the details of skill-based assessment of human resources, drawing inspiration from Lightcast, a global labor market analytics firm renowned for its skill taxonomy constructed from online job posting data.

Figure 9: A framework for disclosing and sharing information that embraces both shared values and skill assessment



Source: Mitsubishi Research Institute, Inc.

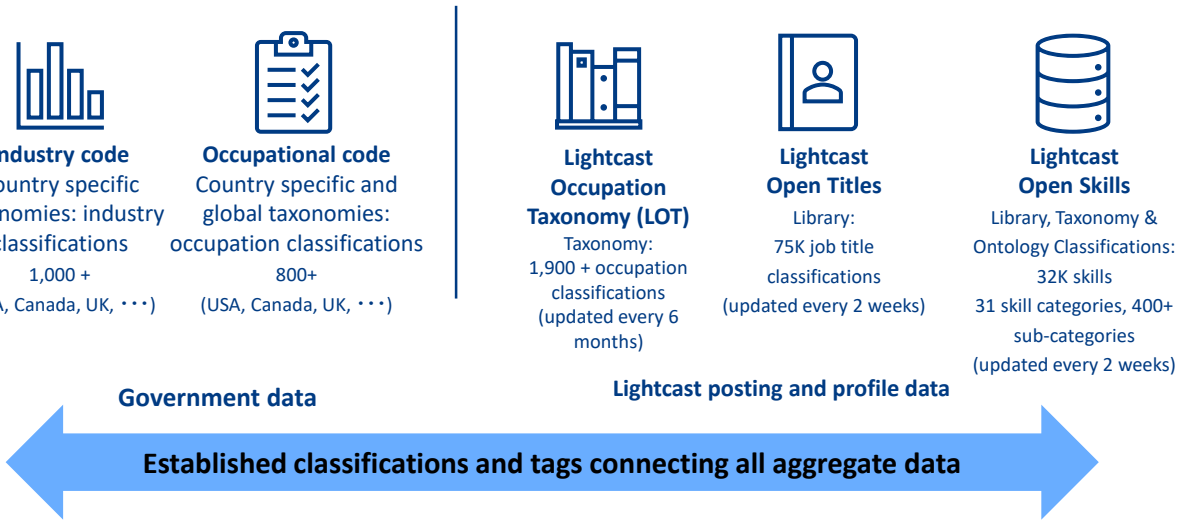
Chapter 3
Assessing Skills through Labor Market Big Data
- Lightcast's skill taxonomy

- Lightcast's skill taxonomy features over 32,000 skills and certifications encompassing a wide range of information, including knowledge areas and competencies.
- This enables assessment of skill similarity, skill disruption, wage premiums, and career pathways.
- Integrating skill taxonomy with a company's internal HR information systems

Skills-based information systems can help resolve labor shortage, labor mismatch, and other issues facing the Japanese labor market. Our analyses refer to data from Lightcast, a US based organization focused on labor market data derived from online job vacancies, with whom we collaborated on this report. Specifically, we used their skill taxonomy information system and labor market big data built from online job postings. Lightcast's skill taxonomy demonstrates high potential when combined with internal HR data and labor market data.

Lightcast is one of the world's largest labor market data providers, formed from the merger of Burning Glass Technologies, founded in 1999, and EMSI, founded in 2000. Lightcast's database of over 1 billion online jobs and career profiles can be analyzed by geography, such as state, county, and zip code in the US, and covers over 95% of the US advertised jobs. Internationally, the database is constantly updated with job posting data that can be collected and analyzed for jobs in a number of countries, including the United Kingdom, Germany,

Figure 10: Type, size, and frequency of updates of data held by Lightcast



Source: Mitsubishi Research Institute, Inc. from Lightcast (2023) "Unlocking New Opportunities in the Global Labor Market"

Canada, Australia and New Zealand. It also has coverage in Southeast Asia and Latin America, including Singapore, Malaysia, and Indonesia as well as in Europe covering EU27 + Switzerland and Norway.

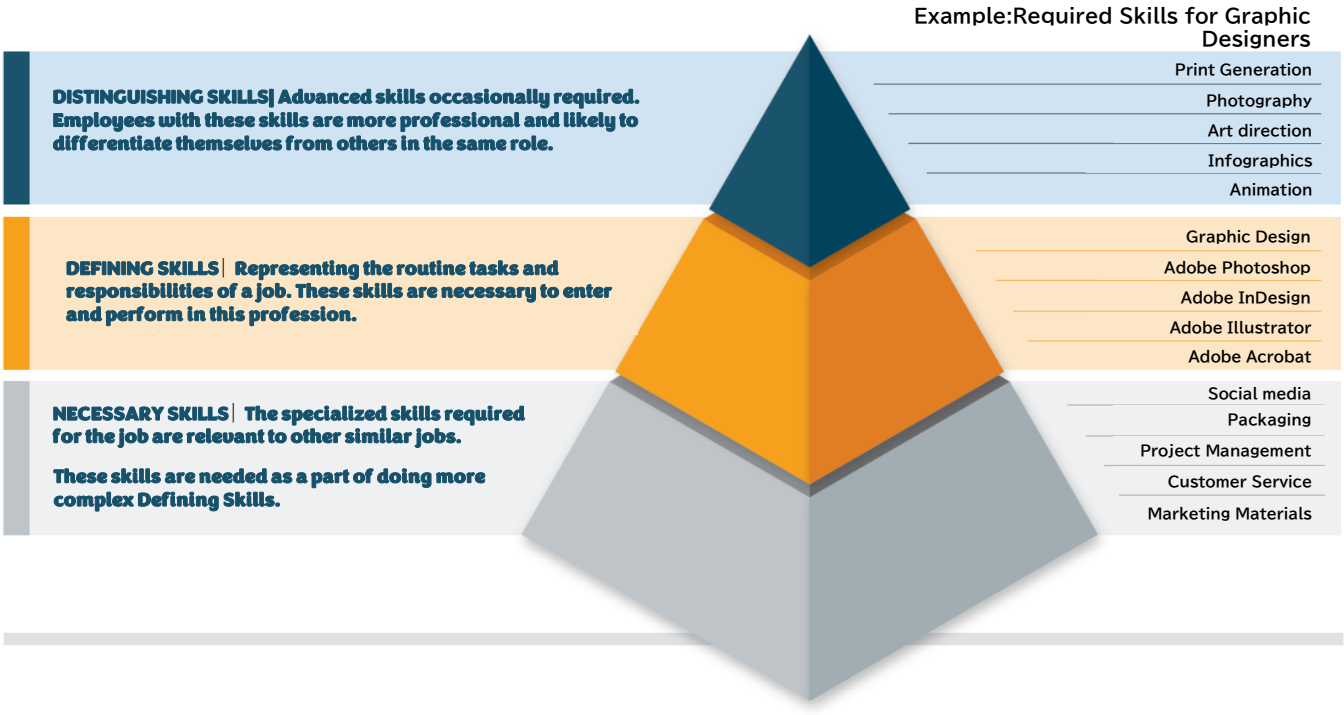
OECD has examined the usefulness of the company's data in 2021, and concluded that "overall, it finds that BGT data exhibit good statistical properties and are a useful source of timely information about labor market demand[10]." Since 2014, there have been more than 100 reports and research papers using Lightcast's data, and a number of independent and joint research results have also been published[11].

Lightcast's data system

Lightcast accumulates labor market data in real time (Figure 10). It has developed three data systems: Lightcast Occupation Taxonomy, Lightcast Open Titles, and Lightcast Open Skills. These are based on online job postings crawled on daily basis, and updated frequently, from days to weeks to months. Importantly, the data systems generated from these online job postings are managed in such a way that they can be matched to the industry and occupational classifications published by each country's government. In labor market analysis, data linkage between different information systems, both within and outside of a country, is a challenge, but Lightcast's industry and occupational classifications can be linked to the U.S. Bureau of Labor Statistics' industry classifications and O*NET's occupational classifications, for example.

Lightcast's skills taxonomy consists of more than 32,000 unique skills and certifications. The company views skills as a very broad concept, and the system is divided into general skills, specialized skills, and qualifications. General skills cover soft skills such as leadership, sociability, and problem solving. Special skills cover knowledge areas such as biology, chemistry, and mathematics, as well as individual programming languages such as Python, C++, and R. The emphasis is not on taxonomical rigor, but rather on comprehensiveness in capturing all the requirements of human resources in the current labor market. The trend toward a broad view of skills has become an important consideration in the information systems that form the foundation for the operation of skill-based organizations, with the World Economic Forum's Skills Taxonomy mentioned above, as well as private consulting firms and skills-tech companies advocating similar broad systems[12].

Figure 11: Occupational skills framework held by Lightcast



Source: Lightcast, "Unlocking New Opportunities in the Global Labor Market", April 2023

Lightcast's skills system is defined across occupations, but the skills associated with each are further reorganized under an occupation-specific skills framework. The position of each skill within a particular occupation is identified by categorizing them into Necessary Skills, Defining Skills, and Distinguishing Skills (Figure 11). The job posting data also provides a way to identify the position of each skill in a particular occupation, and it is linked to wage information. This enables assessment of not only the average wage by occupation, but also the wage level corresponding to the skill mix within the same occupation.

Skills indicators illustrated by job posting data

Lightcast produces and publishes a variety of skill-related indicators based on its data system. Some of the main indicators that are extrapolated from job posting data collected and accumulated daily include the Skill Disruption Index, skill similarity, and skill-based career path.

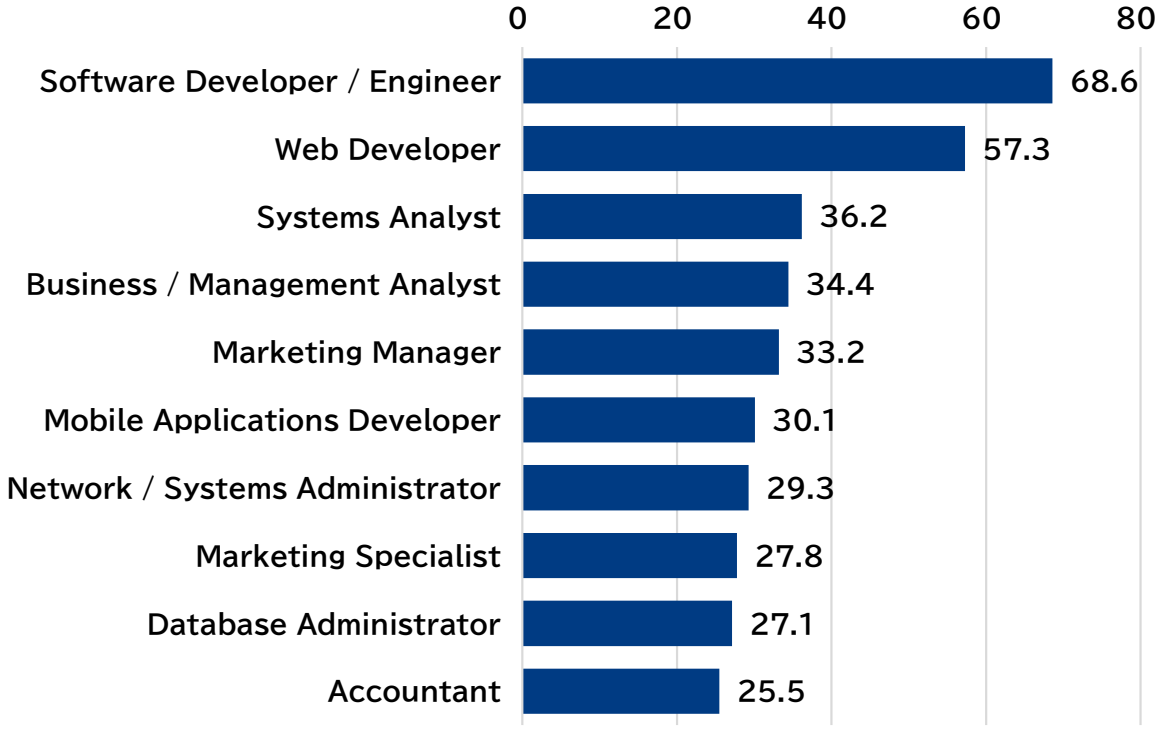
(1) Skill Disruption Index

The changes in industrial structure as a result of DX and GX will significantly alter occupational needs, but as indicated in chapter 1, it is skill needs that will change even more rapidly than occupational demand. Lightcast publishes the Skill Disruption Index, cataloging changes in skill needs by occupation. The index is based on data covering the composition of skills by occupation over the past five years. The index covers multiple countries, such as US, UK, Germany, and Singapore, and can be sorted in various ways, such as descending order of rank (Figure 12). Interestingly, many of the occupations with high skill disruption indices are IT occupations, which see growing demand. This indicates that even if a worker is in a high-demand occupation, it is difficult to remain active in that occupation without constant reskilling and upskilling. This perspective also suggests that assessment of skills is important.

(2) Skill similarity

When considering career advancement to a growth area, it is desirable to make the most of one's own skill set. Lightcast supports reskilling and career development by calculating skill similarity based on the skill mix of each occupation. Figure 13 shows an example of visualizing occupations with high

Figure 12: Occupations with high skill disruption index (Top 10 in US, UK, Germany, Singapore)



Note: Skill disruption index is based on the 5-year change (2017-22) in the skill share of occupations, which are then normalized on a 0-100 scale. Occupations with less than 100 postings are filtered out from the analysis.

Source: Mitsubishi Research Institute, Inc. from Lightcast job posting data

similarity for web developers. Here, ten occupations are selected, led by software developers. By showing the difference in average wages between the selected occupations and those of web developers, it is possible to obtain information on the prospects for wage increases.

(3) Skill-based career pathway

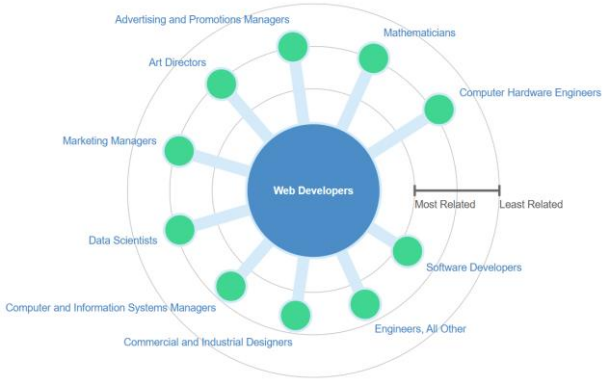
Once occupations have been identified that are highly similar to one's skill set and have a high potential for wage growth, it is desirable to further identify the specific skills needed for career advancement. Lightcast assesses skills that overlap with the skill sets of the target occupations as *overlap skills*, and skills that require new acquisitions as *bridge skills* (Figure 14). Listing average wages in the market enables the quantitative understanding of cost-effectiveness in career advancement and internal skill development.

Use of job posting data within companies

The skill-based organization is gaining steam in Europe and the US (chapter 2). Lightcast's skill system and job posting data is also useful as a benchmark for converting a company's organization and work system to a skill-based one.

The use of Lightcast's data follows three steps (Figure 15). The first step is to map a company's occupations and roles to job titles based on the job posting data. The mapping targets here are occupational classifications and occupational titles

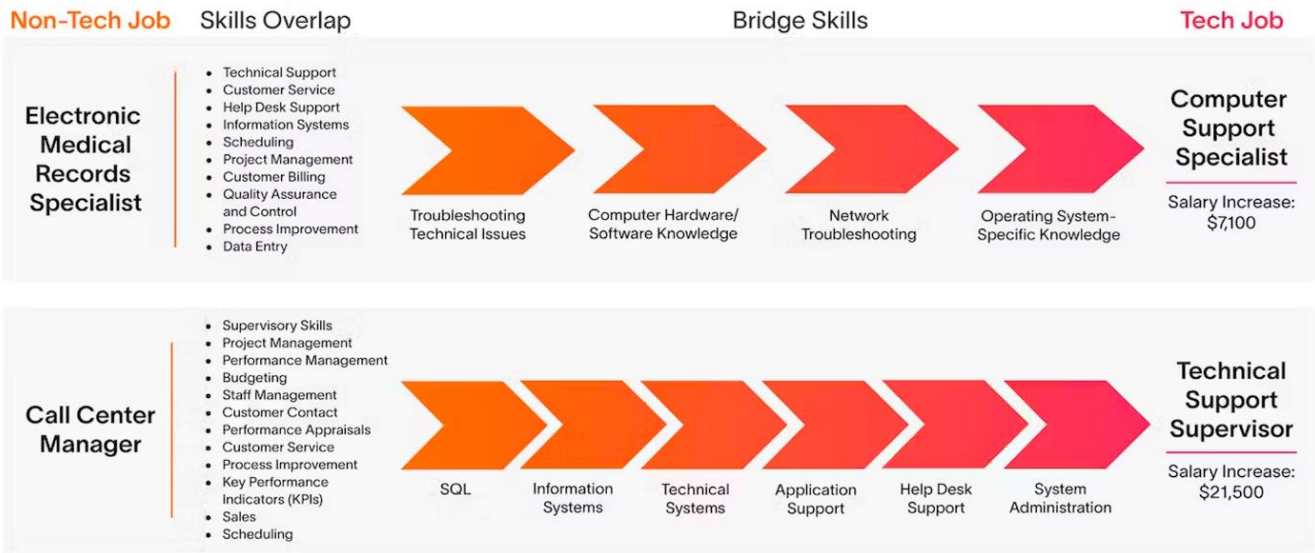
Figure 13: Visualization of next-step occupations (web developers)



Occupation	Relevance	Difference from average wage
Software Developers	88%	$12,124
Engineers, All Other	73%	$5,224
Commercial and Industrial Designers	71%	$6,397
Computer and Information Systems Managers	71%	$47,434
Data Scientists	55%	-$4,879
Marketing Managers	54%	$14,513
Art Directors	54%	$6,900
Advertising and Promotions Managers	49%	-$10,066
Mathematicians	49%	$17,167
Computer Hardware Engineers	43%	$23,227

Source: Mitsubishi Research Institute, Inc. from Lightcast job posting data

Figure 14: Example of skill-based career pathways



Source: Mitsubishi Research Institute, Inc. from Lightcast job posting data

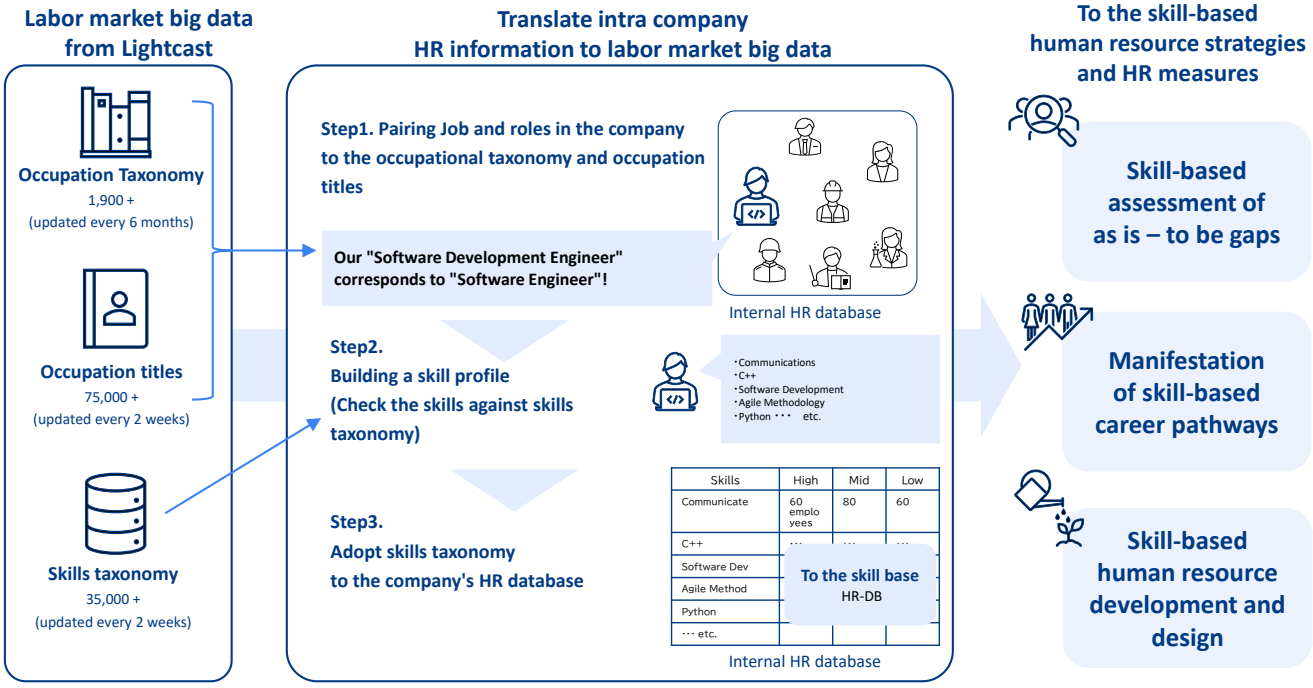
that can be linked to the occupational classifications in government statistics. The second step is to build skill profiles for each in-house occupation and role based on external data. Skill profiles that can be linked to the external labor market are constructed based on the occupational and role-specific skill structure in the external companies and industries to be benchmarked. The third step is to incorporate the skill profiles into the company's HR system and utilize them in the company's policies. HR measures such as assessment of the gap between the future labor demand and base-case labor supply in the skill-based human resource portfolio, clarification of career paths, and human-resource development design can be linked to the external market and constantly updated.

Defining jobs and roles within a common skill system for each company is an effort to improve the understanding of both employers and employees on what skills are needed and can be utilized for the job. Human resource mobility across companies is an inevitable trend, and human-resource assessment must not be limited to a closed framework within one company. The use of labor market big data in the external labor market, such as that offered by Lightcast, is indispensable for the assessment of human capital in companies that aim to be skill-based organizations.

Utilizing job posting data in local economies

So far, our emphasis has primarily centered on optimizing data employment within enterprises. Nevertheless, the exploitation of comprehensive labor market data, structured around a unified skill taxonomy, holds significant potential in steering human resource development within the local economy. In the forthcoming Chapters 4 and 5, we will conduct case studies showcasing the application of skill-based data in regional economies. Our focus will be directed towards two sectors gaining prominence in the Japanese economic landscape: the semiconductor industry and offshore wind power generation industry.

Figure 15: Utilizing skill-based labor market big data in the enterprise



Source: Mitsubishi Research Institute, Inc. from Lightcast (2023) "Unlocking New Opportunities in the Global Labor Market"

BOX2: Can US Job Posting Data Be Used in Japan?

-A Comparison of US and Japanese Jobs Using Occupational Information Data

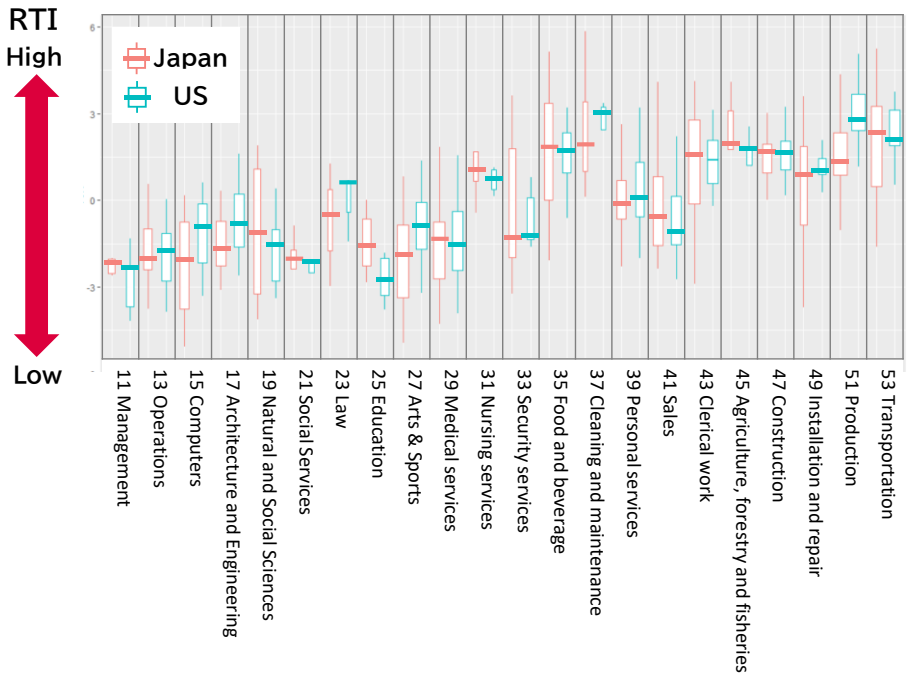
This report examines job similarities and reskilling based on overseas online job postings, primarily in the US and UK. However, it is important to consider the reliability of utilizing overseas job data for analysis due to variations in job descriptions between Japan and other countries, even within the same occupation. We aim to establish the credibility of applying overseas job information to the analysis of the Japanese labor market by conducting a comparative study on occupational characteristics between Japan and the United States.

The US has a website called the Occupational Information Network, or O*NET, that provides information on more than 1,000 occupations. Similarly, in Japan, a Japanese version of O*NET, commonly referred to as Job Tag, is currently under development. As these sites share similar systems and present comparable occupational characteristics, similarities and differences between occupational characteristics of the US and Japan can be analyzed leveraging data from both platforms.

Figure 16 shows a boxplot of *routineness*, or the regularity of job content, by occupational category from both data sets. Pink represents the score for Japan and light blue for the United States. The higher this score is, the higher the routine nature of the job. Conversely, the lower this score is, the more non-routine the job is, and the more flexibility and creativity it requires.
First, as a general observation, there is no significant divergence between the US and Japan. Looking at the thick lines, there are few major differences in any of the occupations, suggesting that there are no significant differences in occupational characteristics.

On the other hand, a slight divergence was observed in the occupations of law, education, arts and sports, cleaning and maintenance, and production. Statistical tests confirmed significant differences only in the education and production occupations. In education, the level of routine tends

Figure 16: Japan-US comparison of occupational characteristics using O*NET data



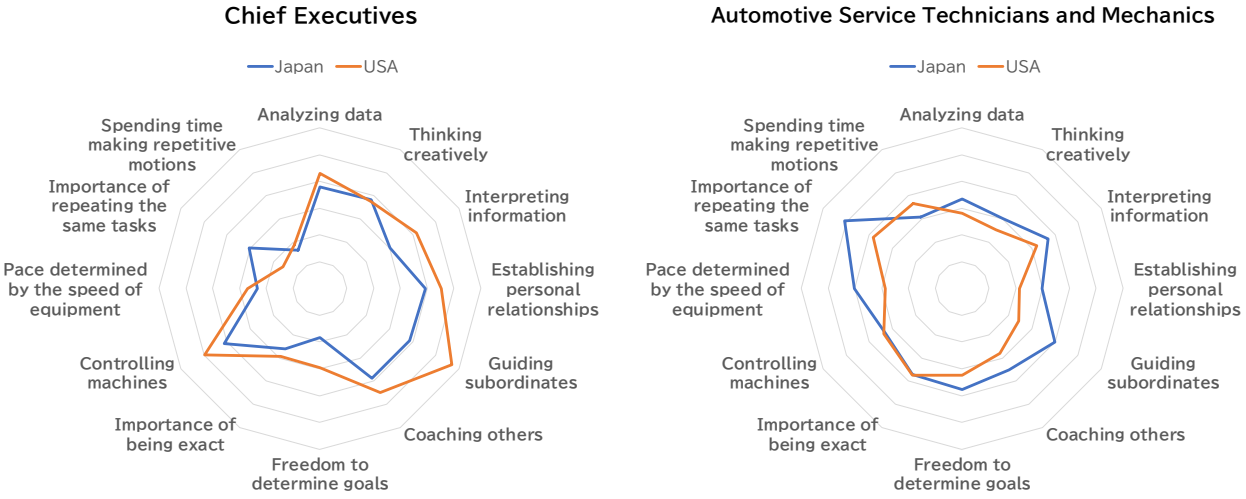
Note: The vertical axis shows the Routine Task Intensity (RTI), with higher values indicating a greater degree of routine tasks. The width of the box-and-whisker chart indicates the number of samples, the thick horizontal line indicates the median, the two ends of the box indicate the standard deviation, and the two ends of the line indicate the 25th and 75th percentile points.
Source: Mitsubishi Research Institute estimates from US O*NET data and Japanese Jobtag data.

to be higher in Japan than in the US. On the other hand, in production, the level of routine tends to be lower in Japan, indicating that there are some job characteristics that differ slightly even within the same job category.
In order to confirm in more detail what job characteristics differ between Japan and the US, Figure 17 shows a radar chart of the 12 individual indicators used to calculate the level of routineness. In the case of Chief Executives (Figure 17, left), Japanese managers are less likely than their US counterparts to be involved in (3) explaining the meaning of information to others and (5) providing guidance, instructions, and motivation to subordinates. This suggests that Japanese managers are slightly behind in terms of appropriately disclosing and explaining management policies and other information internally and externally, and in motivating and leading employees.
On the other hand, auto mechanics (Figure 17, right), who belong to the installation/repair category, are, in contrast to company managers, higher in Japan than in the US in items such as (5) provide guidance, instructions, and motivation to subordinates. This suggested that on-site teams are able to build relationships and appropriately instruct and synchronize teams during on-the-job training.

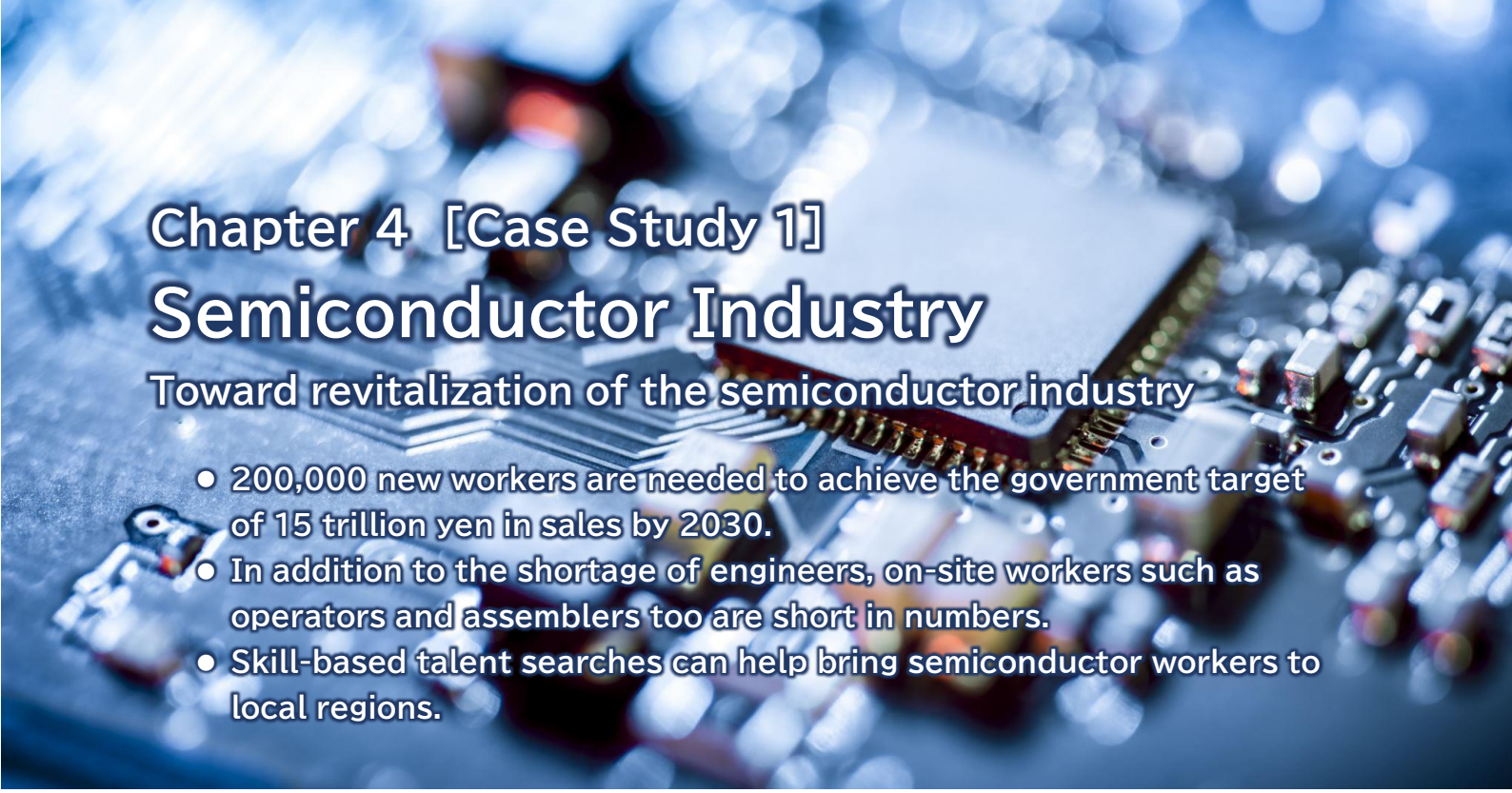
As mentioned above, the specific job characteristics included in some occupations differ from one country to another, making it difficult to apply the information on jobs in other countries directly to Japan. On the other hand, in general, there are no major differences in job characteristics between Japan and the US, and even for occupations with differences in routineness, the general trends are similar, although the situation differs to some extent. Therefore, it is not necessarily difficult to utilize information from other countries as information on skills that are currently insufficiently accumulated in the Japanese labor market. It is necessary to develop domestic information while utilizing such information.

The following is a summary of the suggestions derived from the results of the comparison of occupational characteristics between Japan and the US.
> Occupational characteristics are generally similar on a broad category level in Japan and the US, and there is a certain validity in using overseas job information in Japan.
> On the other hand, certain differences in job characteristics can be observed in certain occupational categories, such as education and production jobs, and caution should be exercised when using overseas information.
> Differences in occupational characteristics do not necessarily hinder the usefulness of such information. Comparison and verification of task and skill characteristics of foreign occupations could be used to explore the direction of reskilling in Japan.
> Analyzing information on job openings and skill systems in other countries may also be beneficial for the development of labor market information in Japan.

Figure 17: Japan-US comparison of occupational characteristics (CEO / automotive service technicians and mechanics)



Source: Mitsubishi Research Institute estimates from US O*NET data and Japanese Jobtag data.



Chapter 4 [Case Study 1]
Semiconductor Industry
Toward revitalization of the semiconductor industry

- 200,000 new workers are needed to achieve the government target of 15 trillion yen in sales by 2030.
- In addition to the shortage of engineers, on-site workers such as operators and assemblers too are short in numbers.
- Skill-based talent searches can help bring semiconductor workers to local regions.

We examined the semiconductor industry in order to verify the usefulness of labor market big data in labor market analysis. Specifically, we estimated the number of semiconductor-related workers needed in the future, where Japan aims for a 15% share of the global market in 2035, and attempted to draw a skills-based model of career shift to the semiconductor industry to achieve this goal.

Increasingly active movement toward the revival of the semiconductor industry

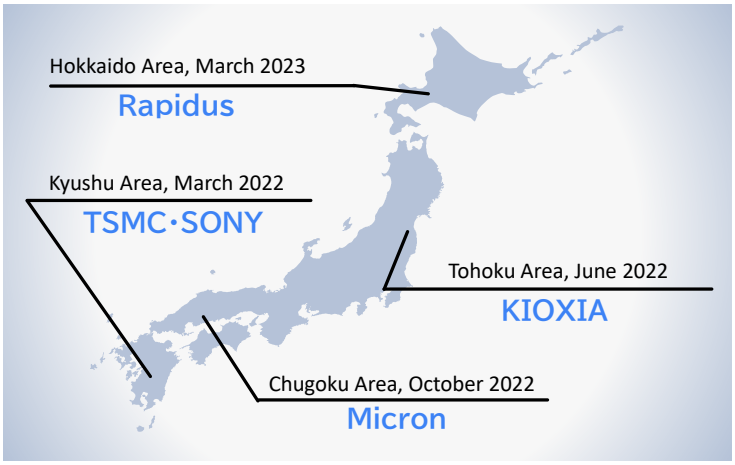
Semiconductors and related products, for which demand is expected to further grow alongside DX and GX, have gained prominence amid discourse on their direct connection with economic security against the backdrop of the US-China feud for technological hegemony. In Japan, the construction of a plant in Kumamoto by TSMC and Sony, two of the world's leading semiconductor manufacturers, and the full-scale launch of Rapidus, which aims to mass produce the world's most advanced logic semiconductors with a circuit line width of 2 nanometers or less, are examples of the active development and production expansion of semiconductor products as a national policy in Japan. Japan's semiconductor industry has been described as having trudged through a "lost 30 years." However, stimulated by the global market and the policies of various countries, the public and private sectors are working together to revive the industry (Figure 18).

Lack of semiconductor human resources for an expanding market

First, based on the actual market size and number of workers in Japan before 2020, we estimate that Japan will need 352,000 semiconductor workers to achieve the desired 15% global market share by 2035. This points to the need to secure nearly 200,000 workers in the coming years (Figure 19).

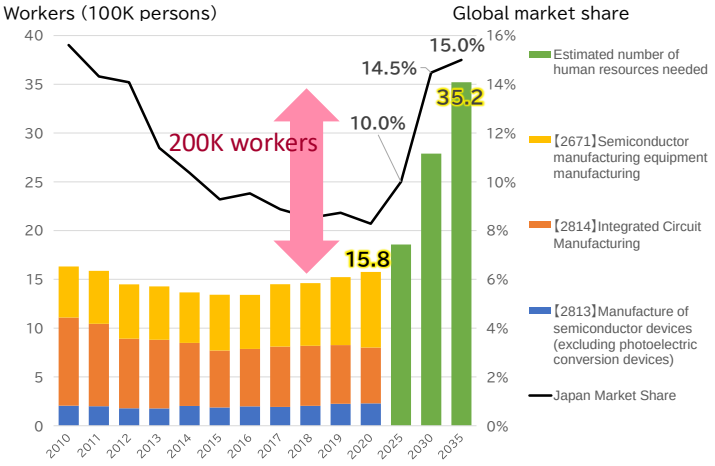
By type of job, there will be a significant shortage of both professional engineers who support the development of technology, products, and manufacturing process design. There will also be a shortage of front-line workers such as production workers who support the mass production stage (Figure 20).

Figure 18: Regional semiconductor consortiums



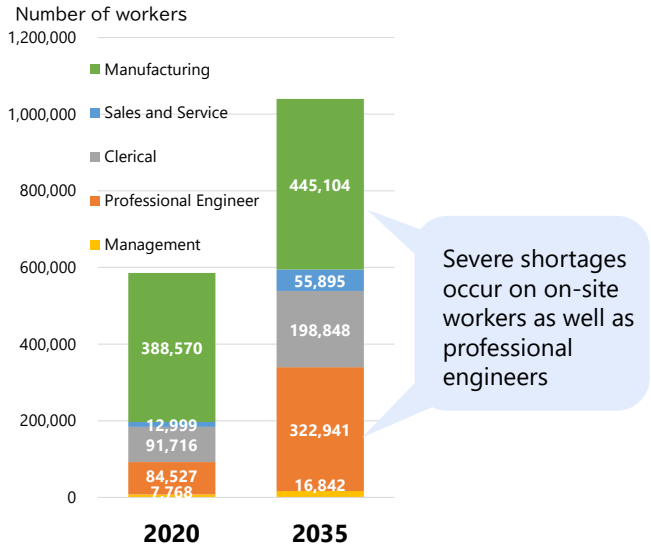
Source: Mitsubishi Research Institute, Inc. from various sources

Figure 19: Size of the domestic semiconductor-related market and the number of workers needed in 2035 (MRI



Source: Mitsubishi Research Institute, Inc.

Figure 20: Projected demand of workers in semiconductor sector in 2035 by occupation



Source: Mitsubishi Research Institute, Inc.

Assessment of semiconductor workforce requirements based on skills

We used Lightcast's labor market big data to identify the necessary human resources by analyzing the US market, which currently leads the semiconductor industry.

The top seven most demanded engineering occupations in the US semiconductor industry in 2022 are shown in Figure 21, which includes software development engineers and industrial engineers as the top two. Figure 21 also outlines the skills required for these positions. IT skills such as Python, debugging, and computer science account for 56% of the skill requirements for high-demand positions. This is followed by engineering skills such as electrical engineering at 32%.

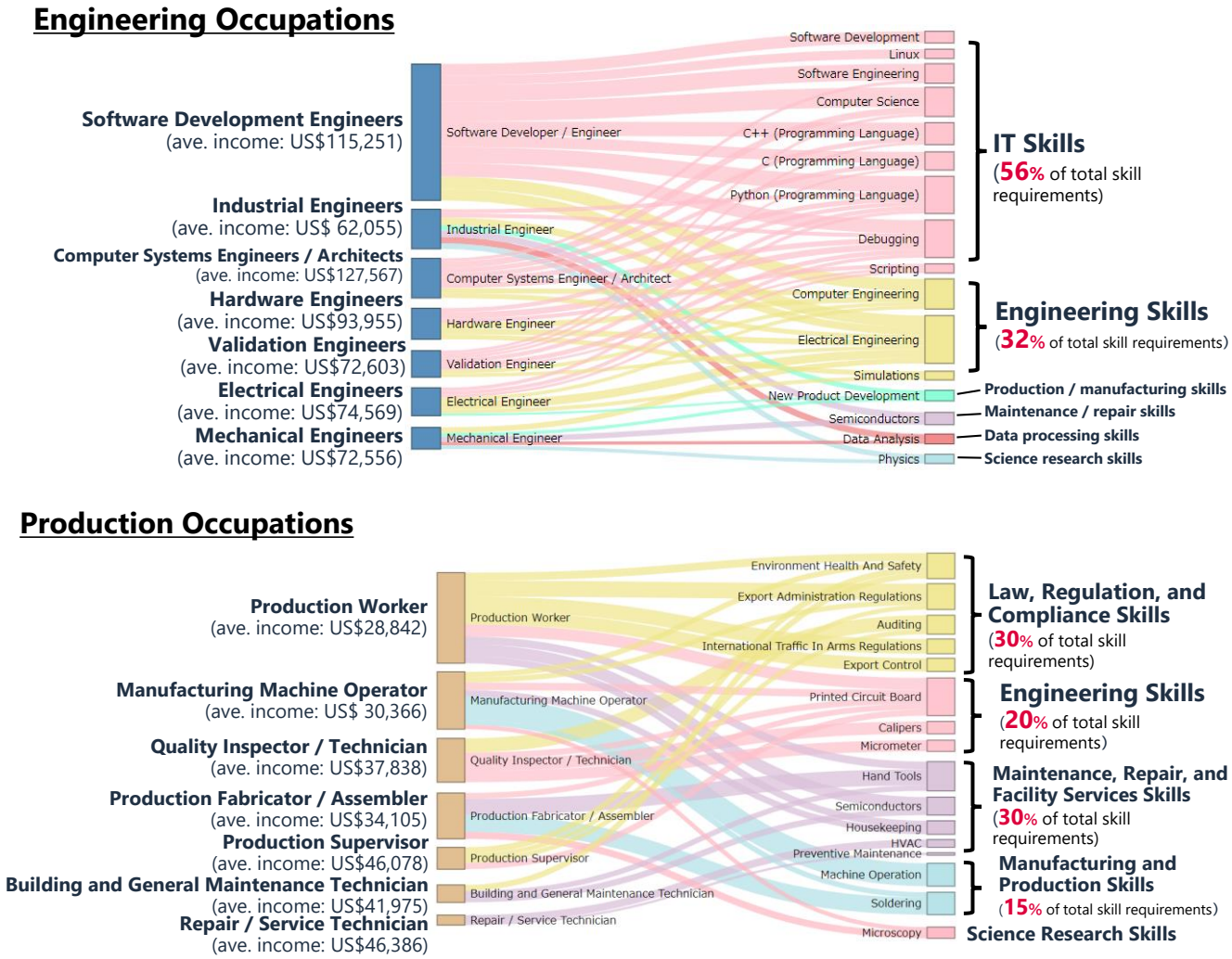
For production occupations, the top seven occupations are production workers, manufacturing machine operators, quality inspectors / technicians, production fabricators / assemblers, production supervisors, building and general maintenance technicians, and repair / service technicians. Specific skills include maintenance, repair, and facility service skills such as capabilities in hand tools and housekeeping. Regulatory and compliance skills account for 30% of the skill requirements for each of the high-need occupations and include expertise in export administration regulations.

From a worker's perspective, even if one does not have experience as a software development engineer, industrial engineer, production process worker, or manufacturing equipment operator in the semiconductor industry, he or she may have IT skills, engineering skills, maintenance, repair, and facility service skills, and regulatory and compliance skills through previous work experience and training. By acquiring these skills through work or training, even those who do not have experience as production process workers or manufacturing equipment operators can easily enter the semiconductor industry. Companies can design new measures such as actively recruiting people with these skills from outside the labor market, or encouraging employees to acquire these skills and reflecting them in development plans, training programs, and other measures.

A Skill-Based Evaluation of Career Prospects

We created a skills-based career outlook for workers who intend to shift their careers to the semiconductor industry in the future. Specifically, we attempt to show workers currently engaged in certain occupations the semiconductor-related occupations with which they have a high affinity, and we quantitatively indicate what skills they should acquire in order to shift their careers to these occupations. The level of expected wage

Figure 21: Top 7 demanded occupations and related skills in semiconductor industry



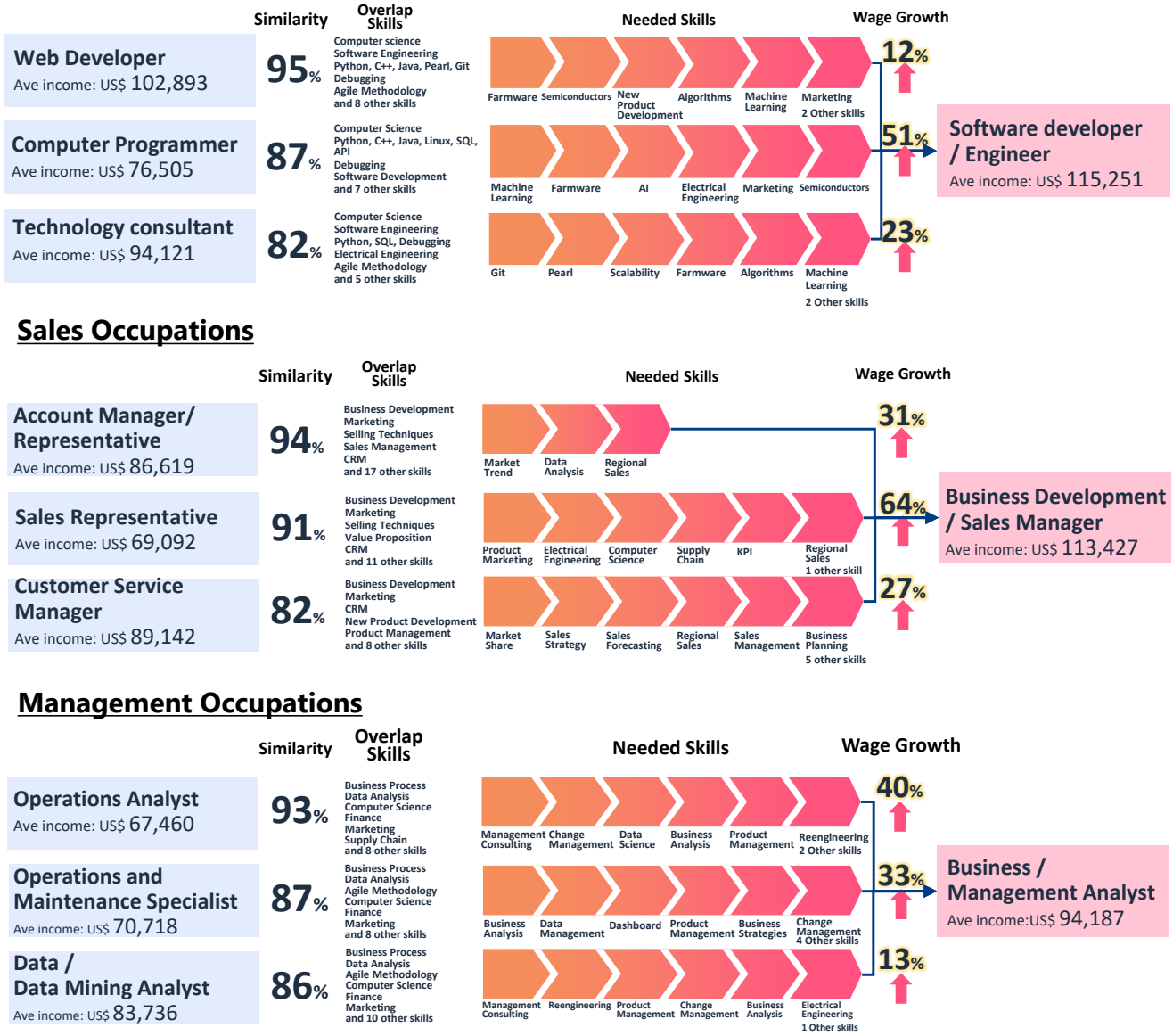
Note: The occupational heights on the left side of the above figure indicate the share of occupations in the 2022 U.S. semiconductor sector job posting data (119,416 samples), and the skill heights on the right side indicate the share of samples in which the relevant skills were referenced in the job posting data shown on the left.

Source: Lightcast job posting data

increase is included, and the analysis was made possible by labor market big data from Lightcast. First, we assessed career prospects for the professional engineering and production occupations using data from the US market (Figure 22). For example, "web developer" has a high affinity with "software development engineer" in the semiconductor industry, with a similarity rate of 95%. Furthermore, by acquiring new skills such as firmware, semiconductor technology, and new product development, job-seekers can match the skill requirements for software development engineers in the semiconductor industry. Such a job-seeker can expect a 12% wage increase when they make the move.

We also examined sales and management positions. As with engineering and production, we assessed career prospects based on data from Lightcast's US market. For example, sales representatives have a 91% similarity to business development and sales managers in the semiconductor industry. By acquiring new skills such as product marketing, electrical engineering, and computer science, job-seekers are able to fulfill the skill requirements of business development and sales managers in the semiconductor industry and expect a 64% increase in pay.

Figure 22: Skill-based career pathways with income premium



Note: "Similarity" in the figure is the cosine similarity based on the skill items included in the job posting and the posting rate.
Newly acquired skills are listed in descending order of the difference in skill posting rates between occupations.
Source: Mitsubisih Research Institute, Inc. from Lightcast job posting data

Skill-based assessment is also useful for achieving semiconductor strategies

To fulfill Japan's ambition of capturing a 15% share of the global market by 2035, the nation faces the daunting task of securing approximately 200,000 new professionals in the semiconductor industry. While local universities and technical colleges are focusing on nurturing fresh talent, relying solely on new graduates falls notably short of meeting the sector's labor needs. MRI's projection suggests that the net increase in workforce between 2020 and 2035, after accounting for senior employees exiting the labor market, falls shy of 100,000. Simple arithmetic reveals that mid-career hires must constitute half of the required talent pool.

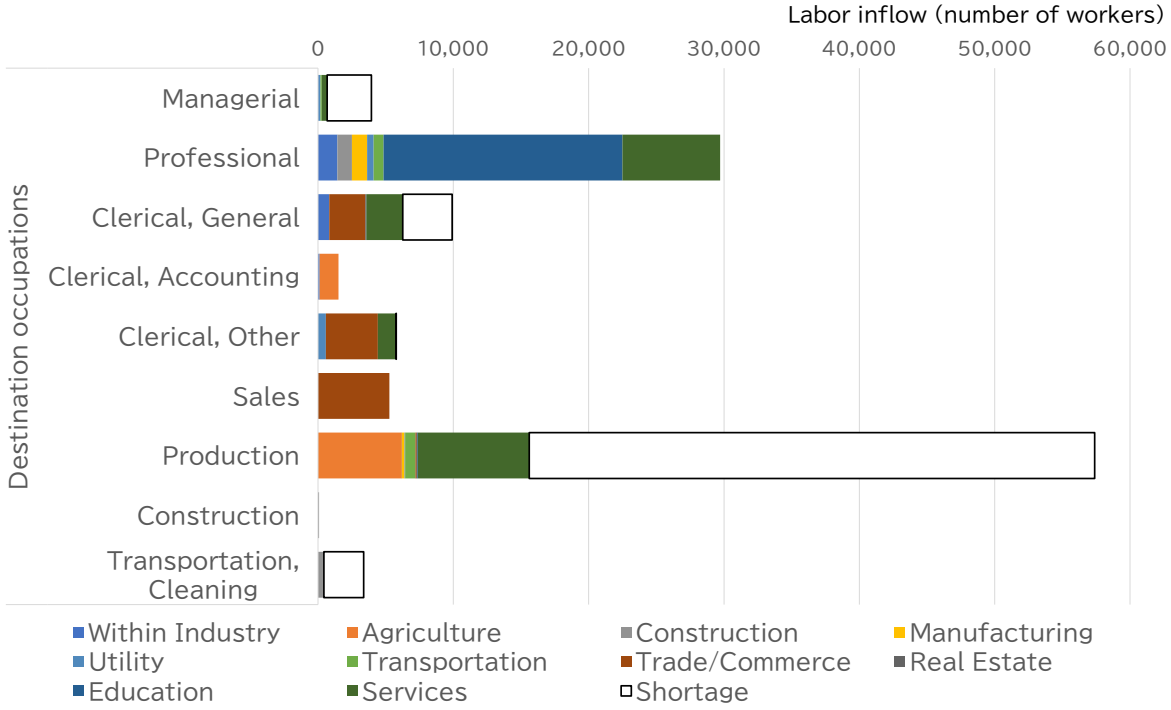
However, one must tread cautiously. High-demand professionals are already in short supply and highly sought after in other burgeoning industries. A simulation presented in Figure 23 demonstrates that a mere 5% of the 30,000 specialized technical positions can be filled by internal transfers within the same industry, while a staggering 95% would need to be recruited from other sectors[13]. Similarly,

the harsh reality is that domestic talent can meet less than 30% of the need for nearly 60,000 on-site production workers.

Given this backdrop, revitalizing Japan's semiconductor industry necessitates significant acquisition of talent from other industries, and potentially from abroad. Yet, for workers without experience in the semiconductor sector or related knowledge, the barriers to entry may seem insurmountable.

Herein lies the value of skill-based big data, such as that held by Lightcast. Leveraging this data can quantitatively demonstrate the high-demand skill sets and compatible career trajectories, thereby facilitating a smoother career transition into the semiconductor sector. These insights are valuable from the perspectives of both nations and regions pushing forward semiconductor strategies, as well as corporations driving the industry. While the case studies currently rely on data from the U.S. market, it is expected that as skill-based data becomes more refined in Japan's labor market, more customized insights can be provided to fit domestic realities.

Figure 23: Projected labor inflow to semiconductor sector through 2035



Note: Labor mobility simulation results addressing the 116,000 workers that cannot be fulfilled through new graduates alone. For details on the methodology, refer to Appendix C.
Source: Mitsubishi Research Institute, Inc.

Chapter 5 [Case Study 2]
Offshore Wind Power Industry
Helping Japan go carbon neutral

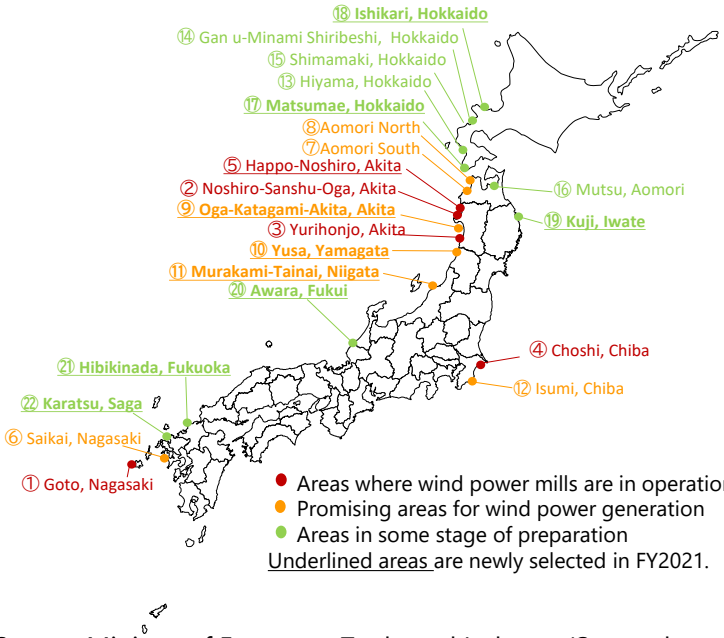
- The offshore wind power sector faces challenges in talent acquisition as it yet lacks solid foothold as an industry.
- The offshore wind power industry requires a diverse set of roles, and thus a rich tapestry of skills, within the project pipeline.
- Exploring the requisite skills and career pathways could benefit from leveraging international job posting data.

To achieve its 2050 carbon neutrality targets, an international commitment, Japan must rehaul its industrial structure toward decarbonization. This green transformation, or GX, encompasses the shift from internal combustion engines to electric vehicles and the transition from fossil-fuel power generation to renewable energy sources. GX will inevitably compel dramatic changes in existing industries. However, GX faces a potential bottleneck in Japan due to talent-supply constraints. The offshore wind power industry, currently seeing growing prominence as a leading source for renewable energy, provides a prominent example of this situation.

Growing importance of offshore wind power in achieving carbon neutrality

Society is increasingly turning to wind power, particularly offshore wind, on the quest to decarbonize. We have proposed ways for Japan to successfully transition to carbon neutrality[14], and according to our scenarios, post-2030 will see a sharp decline in the capacity of existing fossil-fuel power sources. At the same time, the share of renewables like solar and wind power is projected to grow significantly. Of this, the installed capacity of wind power is estimated to constitute about 25%, or 135GW, of the total by 2050, with offshore wind power making up 90GW of this figure. The growth rate for wind power is substantial compared to other energy sources considering it contributed less than 1% of the total power generation in 2020. The industry is already honing in on suitable regions in Japan, and operator selections are already underway in some areas (Figure 24).

Figure 24: Potential areas for offshore wind power in Japan



Source: Ministry of Economy, Trade and Industry (September 2021) "Efforts to Promote the Introduction of Offshore Wind Power" URL: https://www8.cao.go.jp/kisei-kaikaku/kisei/conference/energy/20210921/210921energy05.pdf (viewed July 11, 2023)

Figure 25: Challenges and endeavors in offshore wind talent development

Nascent stage of the industry	• Industry lacks a solid foundation compared to oil and gas • Deficit in expertise and know-how regarding essential industry skills • Impending need to adopt future technologies, including AI/IoT and other digital innovations
Industrial transition towards green growth	• Towards a carbon-neutral 2050, Japan must craft and execute a novel industrial growth strategy in pursuit of green prosperity • Stimulating transitions from synergistic existing industries, such as the conventional and nuclear power and the aviation industries, is imperative
Pervasive labor shortage in Japan	• Japan grapples with manpower challenges that transcend the offshore wind sector (e.g. construction sector) • Imperative need for mechanisms and legislative frameworks that foster greater integration of international talent

Source: Japan Wind Power Association (JWPA) "Offshore Wind Skill Guide, 1st Edition"

40,000 workers needed in 2035

Adequately staffing this nascent industry presents a formidable challenge. The Japan Wind Power Association (JWPA) has identified three principal challenges facing talent development: the sector's immaturity, the transitional dynamics of the green growth industry, and an overarching labor shortage throughout Japan (Figure 25). In 2022, JWPA unveiled the *Offshore Wind Skill Guide*, a meticulous breakdown of skill requirements for pivotal roles within the sector. Offshore wind power encompasses an expansive range of activities from research and design to manufacturing, installation, operations, maintenance, and even decommissioning. This necessitates a diverse pool of talent with an array of skills.

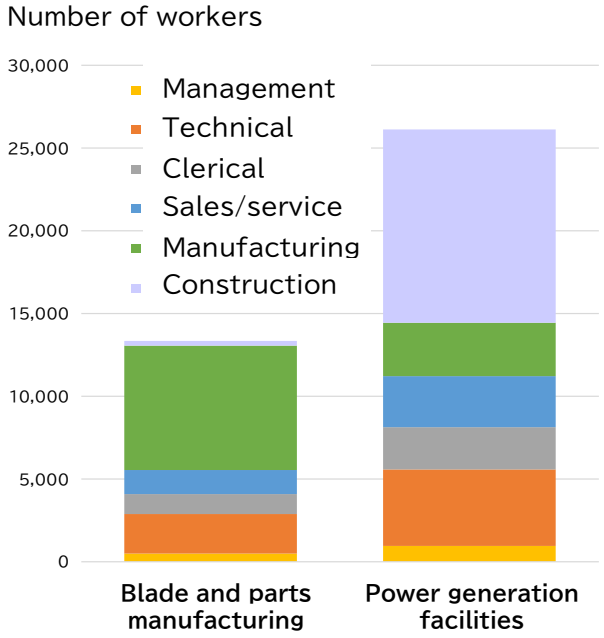
Based on our estimates of expected power output, we foresee employment in the offshore wind sector reaching around 13,000 in the turbine and blade manufacturing sectors and approximately 26,000 in facility construction, a total of close to 40,000 personnel (Figure 26). Unlike the semiconductor industry, offshore wind power lacks an existing industrial foundation in Japan, emphasizing the pressing need for talent cultivation and acquisition from scratch. This highlights the urgency of transferring talent from existing industries and promoting the integration of international expertise.

Broad skill demands of offshore wind power workers

We used job posting data from Lightcast to assess the skills required of the offshore wind power industry. However, given the nascent state of the sector in Japan, we have used data from the mature UK offshore wind market (Figure 27).

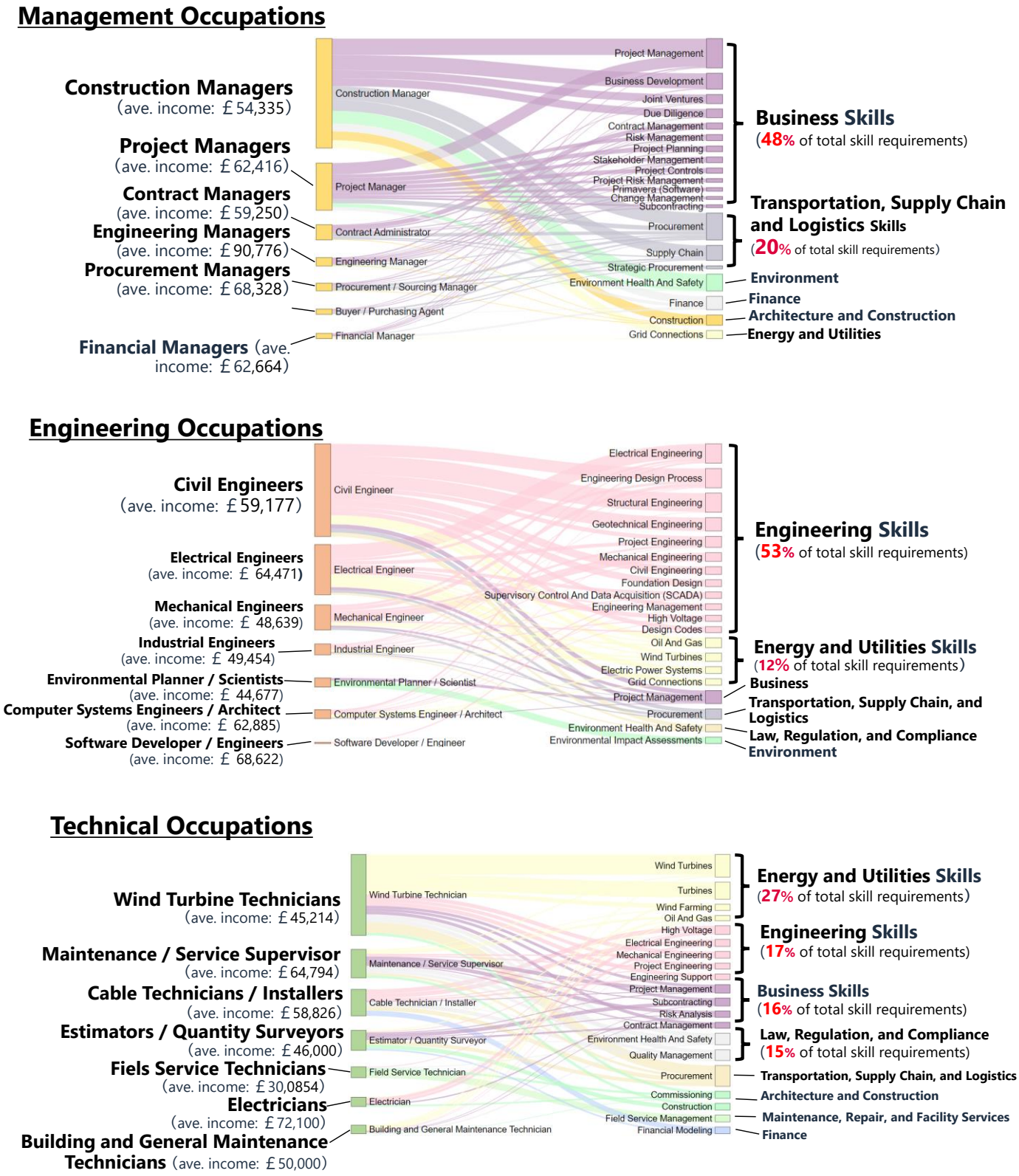
In 2022, the management tier of the UK's offshore wind power sector shows high demand for roles such as Construction Managers and Project Managers. Nearly half of the high-demand skills for these roles encompass business-centric capabilities like project management, business development, joint ventures, and due diligence. Yet, in addition to these, there is also a significant demand for expertise in supply chain management, environmental science, finance, construction, and energy.

Figure 26: Projected demand of workers in offshore wind sector in 2035 by occupation



Source: Mitsubishi Research Institute, Inc.

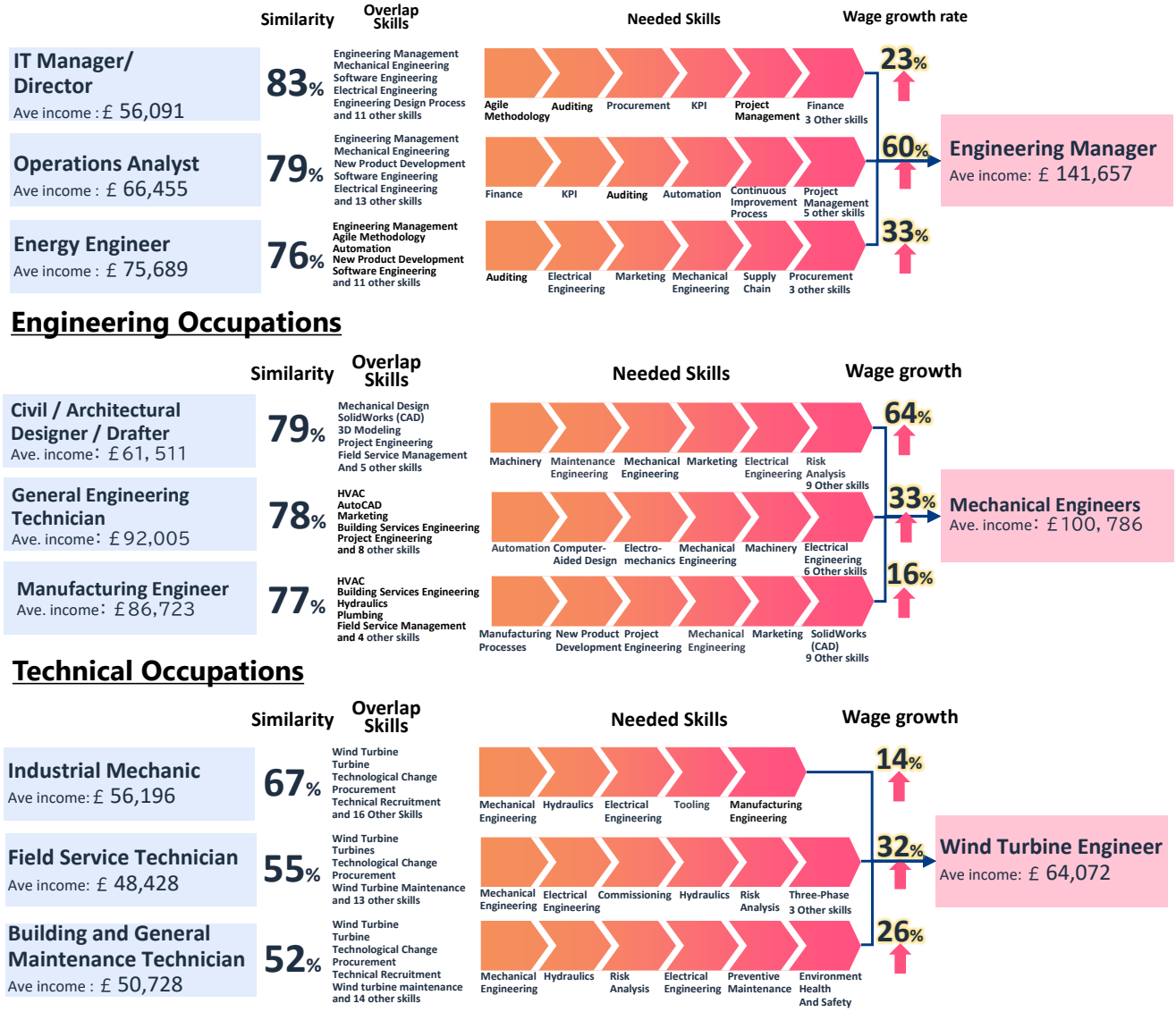
Figure 27: Top seven occupations in demand in the offshore wind power industry and the related skills



Note: The occupational heights on the left side of the above figure indicate the share of occupations in 2022 UK offshore wind sector job posting data (9,928 samples), and the skill heights on the right side indicate the share of samples in which the relevant skills were referenced in the job posting data shown on the left.

Source: Lightcast

Figure 28: Skill-based career pathways with income premium



Note: "Similarity" in the figure is the cosine similarity based on the skill items included in the job posting and the posting rate. Newly acquired skills are listed in descending order of the difference in skill posting rates between occupations.
Source: Mitsubisih Research Institute, Inc. from Lightcast job posting data

In the realm of engineering, Civil Engineers are most in demand, followed by Electrical Engineers and Mechanical Engineers. As would be expected, engineering skills dominate the categories of high-demand expertise. However, the offshore wind industry is poised for a digital transformation. Anticipated advancements in operations and maintenance—driven by digital twins and data monitoring—signal a rising need for digital skills. Consequently, a surge in demand for IT-related expertise seems inevitable, underscoring the necessity for real-time labor market intelligence.

As for technicians, who represent the industry's frontline workforce, the skillset required is as diverse as that for management and engineering positions. Beyond turbine-related skills, a broad spectrum of abilities—from engineering and business acumen to regulatory and compliance understanding—are essential. Interestingly, the skills unique to the offshore wind power sector, such as those related to energy and regulations, are relatively confined. This specificity illuminates the opportunity for skilled workers from other sectors, such as civil engineering and construction, to transition into this burgeoning field.

A skill-based evaluation of career prospects

Career prospects within the offshore wind power sector can be made clearer by offering visualizations of career paths into high-demand roles and the corresponding skill sets required. We examine three particular roles for this assessment: Engineering Managers, Mechanical Engineers, and Wind Turbine Technicians (Figure 28). In each of these career tracks, targeted reskilling shows clear potential for transitioning to high-demand, high-paying roles.

The offshore wind power industry needs to cultivate and attract talent essentially from scratch, and it is imperative to identify and recruit talent with transferrable skills from other sectors. Through the analysis of job-posting data, the industry can locate latent talent and offer targeted reskilling programs along with explicit career prospects. This is particularly vital for accelerating talent influx into this key sector geared toward global sustainability initiatives.

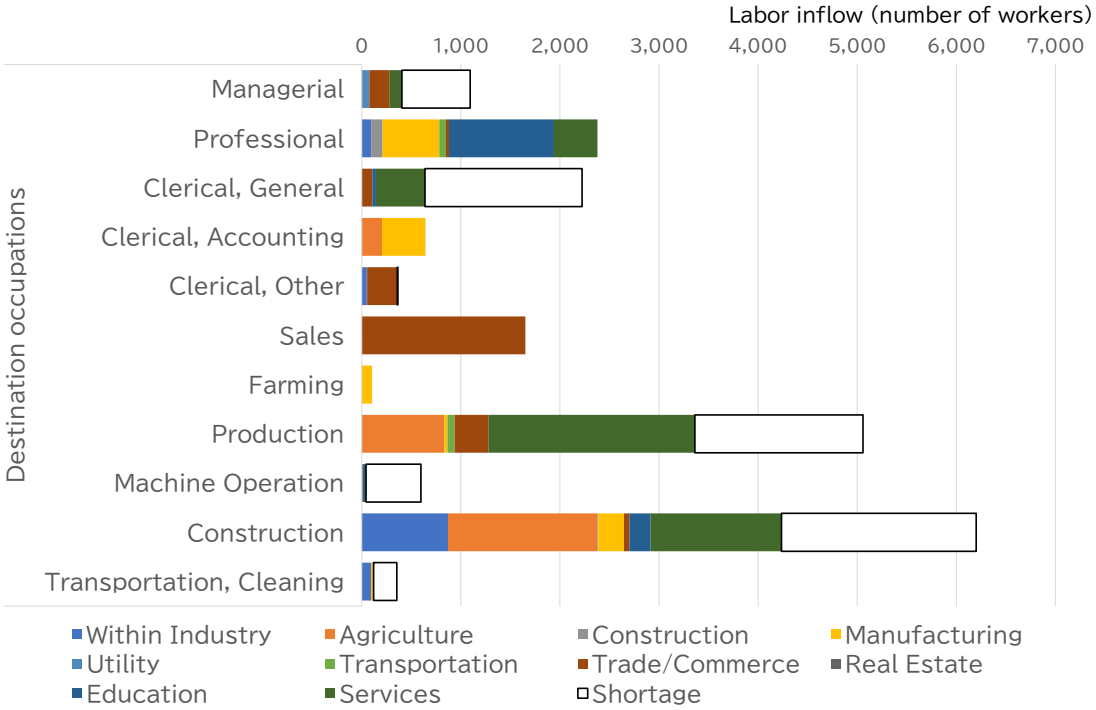
Leveraging skill-based data for securing talent

We simulated talent migration through 2035 and the results make clear the severity of the human capital challenge facing the sector (Figure 29).

Talent shortages are worsening across specializations, including technical roles, production, and construction. Current projections suggest a shortfall of about 7,000 positions from the required 40,000, mainly in production and construction, even after accounting for an estimated inflow of 19,000 new graduates.

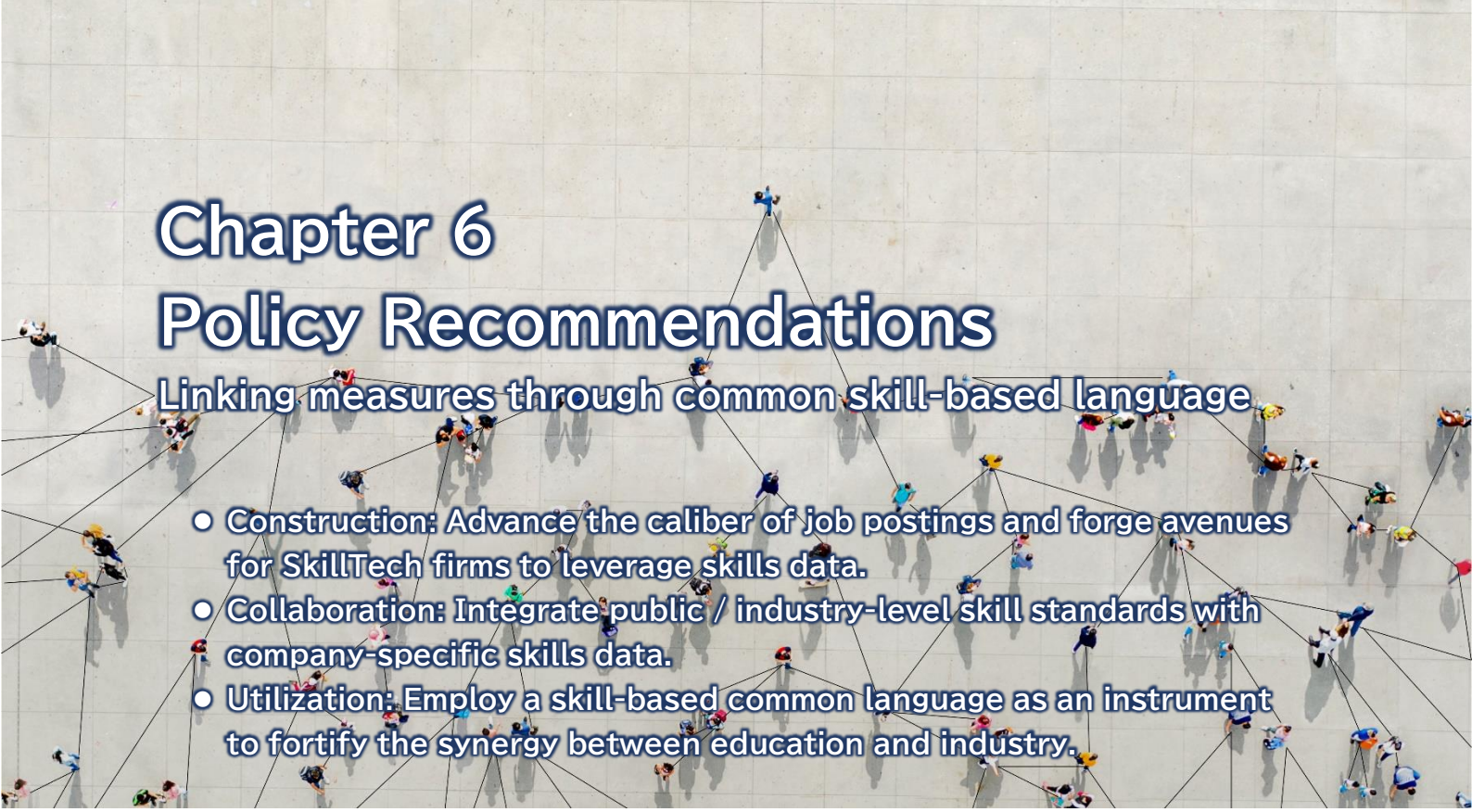
While managerial and technical roles can, to an extent, be sourced without geographical constraints, the acquisition of on-site maintenance staff necessitates local hiring. In this regard, one strategy could involve setting up collaborative regional frameworks aimed at attracting talent from more mature industries within the same area. Utilizing the skill-based data outlined in this report could be a valuable asset for such talent-acquisition initiatives.

Figure 29: Projected labor inflow to offshore wind power sector through 2035



Note: Labor mobility simulation results addressing the 116,000 positions that cannot be filled through new graduates alone. Appendix C offers details on the methodology.

Source: Mitsubishi Research Institute, Inc.



Chapter 6
Policy Recommendations

Linking measures through common skill-based language

- Construction: Advance the caliber of job postings and forge avenues for SkillTech firms to leverage skills data.
- Collaboration: Integrate public / industry-level skill standards with company-specific skills data.
- Utilization: Employ a skill-based common language as an instrument to fortify the synergy between education and industry.

To achieve DX, GX and the revitalization of the domestic semiconductor industry, human resource requirements will change significantly and human resource mobility will increase. Society will need high-quality information to enable labor market participants to make appropriate decisions. In Japan, human resource information is scattered across the national government, companies, human resource service providers, and educational institutions. Furthermore, this information remains incoherent, lacking a common language that all participants can understand. If human resource mobility is promoted under these conditions, there is concern that serious human resource mismatch will increase the unemployment rate and impede economic growth.
In this report, we have focused on knowledge, the starting point of the FLAP cycle, and discussed how information should be shared and disclosed in the Japanese labor market—essential for better fluidity in the future. While there are a wide range of measures that should be taken to reform the labor market, we focus here on the development of information and recommend the six points in particular (Figure 30).

1. Improve the quality of job posting data

The skills-related data presented in chapter 3 and used in the case study analysis of chapters 4 and 5 were all constructed from online job postings collected abroad. It would be preferable to conduct the analysis based on job information within the Japanese labor market. Unfortunately, however, the job information currently available in Japan does not meet the conditions required for skill-based labor market big data.
In Japan, the traditional emphasis on lifetime employment and seniority-based wages has led to a lesser emphasis on detailed job descriptions. Consequently, job postings in Japan frequently lack specific information regarding required skills and experience. Given the nature of the Japanese employment system, it is not surprising that labor data in Japan often lacks sufficient information on skills.

As the future envisions a more mobile workforce, it becomes increasingly important to establish clear definitions of needed roles and the corresponding skills required to perform specific tasks. The HR services industry has an important role to play here as an intermediary in the labor market.

The government guidelines for the three-pronged labor-market reform call on the Japan Association of Human Resource Services Industry (JHR) to consider ways to consolidate job information held by private human resource companies. JHR must implement measures to enhance the quality of job information, which include offering a standardized format for job postings to recruiters and ensuring the uniformity of information gathered throughout the job search process. Additionally, when standardizing the collected Information, it Is crucial to consider its alignment with skill taxonomies used in countries outside Japan.

2. Enhance methods for skill-data analytics

The analytics of skill-based labor market big data is an evolving field with much room for refinement. Even established skill tech companies like Lightcast, with over a decade of expertise in data storage and analysis, recognize the numerous challenges associated with skill analysis.

One notable challenge is the lack of specificity regarding skill proficiency levels in job postings. While job descriptions often mention required skills, they rarely indicate the desired proficiency level for each skill. In fact, even within an organization's own talent management, it can be difficult to accurately measure skill proficiency on an appropriate scale. Visualizing the value created by combining multiple skills is also an important issue. Skilltech firms in Europe and the US are experimenting with capturing skills collectively as skill clusters, but these efforts are not yet fully established.

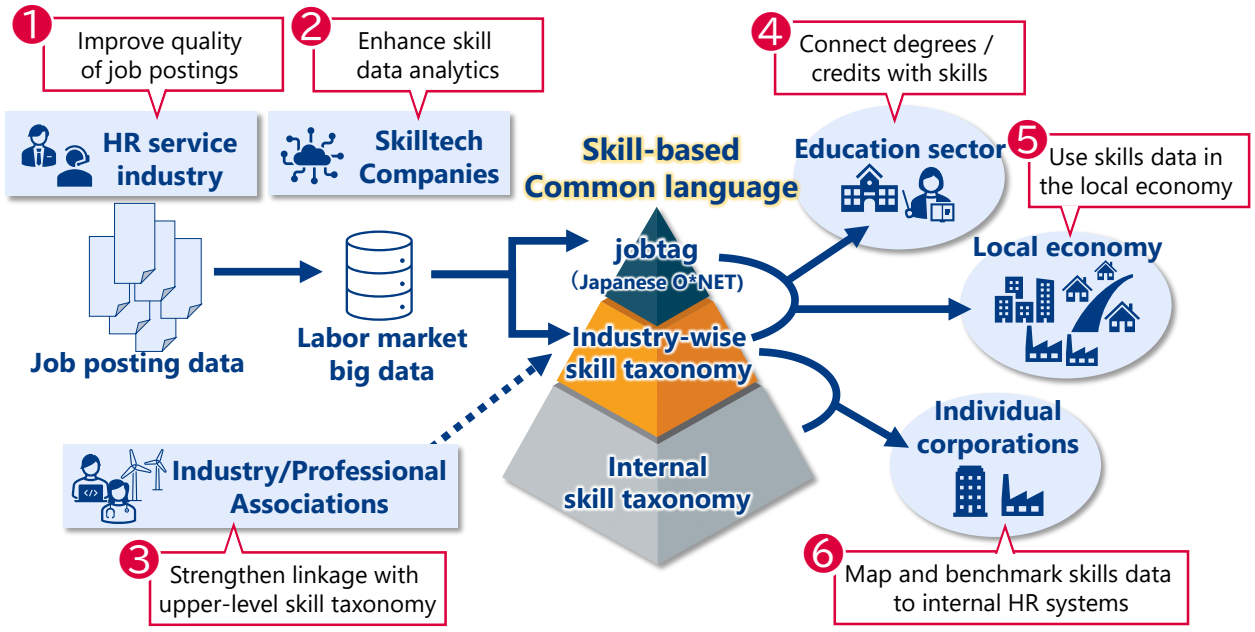
The recent, remarkable development of AI, especially generative AI, has the potential to greatly expand the possibilities for assessing skills. Generative AI is already being applied to HR in the US. Japan too should soon see the emergence of skilltech companies that make full use of advanced skill-data analytics to keep pace with improvements in the quality of job postings.

3. Link industry and occupational skill systems

The consensus among European and US skilltech is that it is unrealistic to build a single common skill system that can be used across all industries and occupations. This is not a negation of a common skill-based language. What this calls for is a higher-level skill system that can easily reflect the characteristics and unique needs of each industry, function, and individual company; industry and occupation specific skill systems should be developed on top of that.
The Japanese version of O-NET, called Job Tag, launched in 2020 and should fill the role of a higher-level skill system. The service features an occupational information database covering more than 500 occupations, with information on job descriptions, required skills, knowledge, and education levels quantified in a comparable format. The database is regularly updated with additional occupational information, and its structure is almost identical to the US version of O*NET. It is appropriate to position Job Tag as a higher-level skills system with a view to coordinating occupational information across countries.

However, since its release, Job Tag has focused on functional enhancements to make it more attractive as an information provider and has not yet taken steps to improve its functionality as an occupational information database; this is problematic. In

Figure 30: Six recommendations for building, linking, and using a common skill-based language



Source: Mitsubishi Research Institute, Inc.

particular, the lack of API connectivity and a movement to consider linking to other qualifications standards calls into question the position of the overarching qualifications system. In addition, questions remain about the frequency and method of updating information. The US started using Lightcast data in 2019 to identify upcoming skills for O*NET. Data updates using real-time labor market data should also be initiated.
The IT Skill Standards (ITSS), which have been in existence for over 20 years, the Caregiver Career Level System for the caregiving industry, and the Offshore Wind Skills Guide, which defines the skills of offshore wind turbine personnel, can be considered to be industry and occupation-specific skill systems. However, there still has been no movement to link these industry-specific skill standards to the Job Tag data system—an issue facing its further use.

4. Link skills to educational content

Connection to educational content is one of the top priorities for leveraging the common skill-based language. Government policy looks to support reskilling, including *open badge measures*, or the digital authentication and display of credentials. Here, it is important that there is a clear link between the skills required and the relevant educational content.

For example, Skills Future Singapore, a reskilling initiative in the city-state, provides an online platform that displays educational content corresponding to the skills required for each occupation and offers a one-stop service to complete course procedures[15]. Once a worker registers his or her occupation and the skills he or she possesses, the system displays the corresponding training content and the skills needed for career advancement. The educational content offered is tied to a variety of formats ranging from online micro-learning to university degrees.

In Japan, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has launched Manapath, a portal site to support recurrent education. Reskilling can be achieved by linking the content on this site to Job Tag's skills system or industry and occupation-specific skills systems.

5. Use skills information to bring talent back to regions throughout the country

A significant portion of the demand for human resources generated by GX and the revitalization of the domestic semiconductor sector will crop up in regions throughout Japan—not just the major cities. At the same time, the expected decline in demand for human resources in sectors such as electricity, steel, and automobiles will also follow the same route. In order to cope with fluctuations in demand and maintain employment stability in its various regions, Japan needs to establish a framework for a flow of human resources to each prefecture and the country's broader regional units.

Please refer to our previous recommendations for details on the formation of a locus for labor migration from mature industries to growth industries[16]. We have also recently proposed the concept of a consortium for human resource development and acquisition in the semiconductor industry, which is also the subject of a case study in this report[17].

Here we suggest that the common skill-based language be used to bring talent back to regional areas. Regional governments, labor-management organizations, and representatives of educational institutions should identify the needs, or growth areas, and seeds, or maturity areas, of local human resources and match workers based on skills to fill any discrepancies. By having workers acquire the necessary skills at local universities, training institutions, and private training centers, policymakers can create a circular flow of human resources within their region.

Intra-regional worker mobility often faces hesitation as it involves the movement of workers of companies in mature sectors. Regional HR revitalization can be set into motion by establishing objective data on human resource demand and skill needs.

6. Improve human capital management by linking corporate skills systems to external data

In order to promote investment in people, companies need to focus now more than ever on disclosing information about their human capital. Since March 2023, such information is already up for access by capital markets, but it will be critical

that the same information find its way to internal and external labor markets moving forward. In order to inspire their own employees and external job seekers to maximize their performance, companies need to effectively express their shared values, goals, and strategies as well as present a clear picture of the human resources needed to achieve them.

The key to assessing human resource needs is to adopt a common skill-based language (Chapter 3). By using a common skill system that is constantly updated through the collection and accumulation of online job information, the skill structure of the human resources required by companies can be mapped and benchmarked against external human resources.

Of course, companies need a wide range of information for their HR policies, and they need to define skill categories and skill levels in greater detail. However, if these are not linked to the external labor market at a higher level, it will be impossible to develop and acquire the human resources needed to increase corporate value, as the information will inevitably become obsolete.

Lastly, we would like to emphasize the need for a change in the mindset of workers. If the recommendations outlined in this report come to fruition, they will grant us greater career autonomy, but they will also entail increased responsibility. With access to labor market information, we will be empowered to evaluate our skills, acquire the necessary competencies for thriving in expanding sectors, and potentially transition across companies and industries according to our preferences.

Naturally, besides the adoption of a common skill-based language, certain assurances will be required, such as dedicated resources for reskilling, a safety net for temporary job loss, and foreseeable compensation for career progression. However, even with the promise of such support, change can only occur if workers have the courage to take the initial step.

Helping all to accurately assess their skills and proactively build an independent career path holds the key to revitalizing Japan's labor market and achieving substantial wage growth.

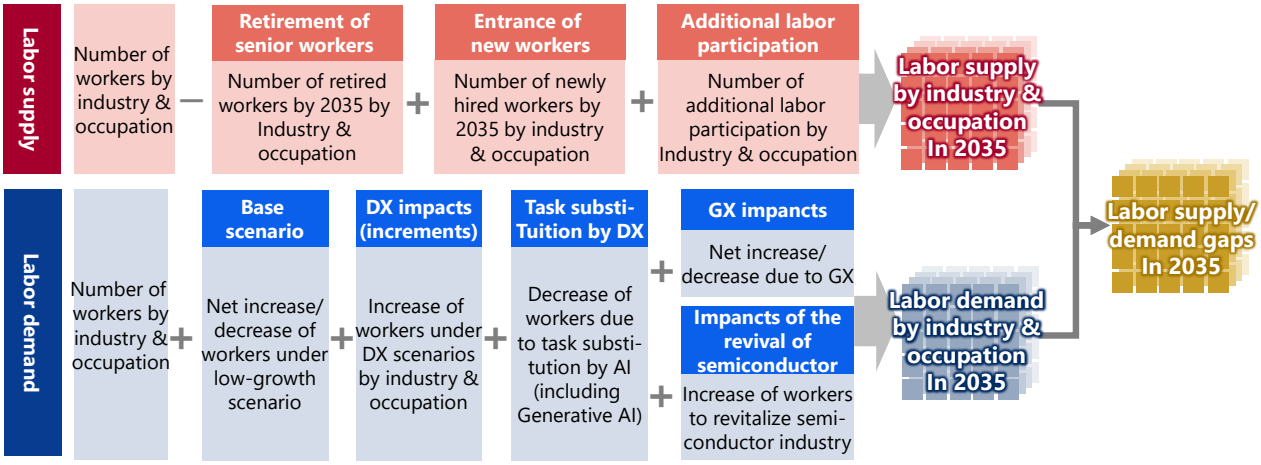
Appendix A: Projections of labor supply and demand through 2035

We carried out a nuanced assessment of the outlook of Japan's labor supply and demand through 2035. On one hand lies the anticipated labor supply, extrapolated from historical trends, standing in contrast to the workforce demands should digital and global transformations—alongside a renaissance in the semiconductor industry—come to fruition. The resulting difference between these two estimations is the labor supply-demand gap.

We used 2020 employment figures as the basis for our labor supply projections. Our estimates took three key factors into consideration: 1) a stable age-specific employment rate leading to retirements by 2035, 2) new entrants into the workforce, calculated from official demographic forecasts and age-gender-specific hiring rates, and 3) incremental labor participation from women and seniors. Our 2035 labor force estimates cover multiple industries and job types, and we have brought them together into an intricate matrix spanning 171 sectors and 227 professions based on the 2015 inter-industry employment matrices.

Our labor demand estimates figures also use the 2020 employment figures. Five key factors were taken into consideration: 1) a baseline scenario assuming sluggish growth at an annual rate of 0.25% and a marginal increase in labor productivity at 0.07%, 2) employment ramifications under 96 digital transformation scenarios entailing the synergy of AI, the Internet of Everything, and robotics, 3) job displacement due to the introduction of generative AI and other digital technologies, which cover roughly 2,000 tasks, 4) employment impacts under a carbon-neutral scenario, and 5) employment effects predicated on Japan capturing a 15% market share in the global semiconductor market by 2035. The labor demand is broken down with equal granularity into 171 sectors and 233 job types, mirroring the supply-side analysis.

Figure A: Framework for labor supply and demand projections through 2035



Source: Mitsubishi Research Institute, Inc.

Appendix B: Calculation of Routine Task Intensity (RTI) using Japan-US O*NET Data

The methodology for calculating the Routine Task Intensity (RTI) based on Japan-US ONET data follows the approach outlined by Lewandowski, Park, Hardy, and Du in their 2019 paper, "Technology, Skills and Globalization: Explaining International Differences in Routine and Nonroutine Work Using Survey Data." Specifically, a Principal Component Analysis (PCA) was carried out using the following 12 indicators: 1) analyzing information and data, 2) creative thinking, 3) explaining the meaning of information to others, 4) building and maintaining relationships, 5) guiding, directing, and motivating subordinates, 6) coaching others and developing their abilities, 7) self-setting of priorities or goals (inverse), 8) rigor and accuracy, 9) controlling mechanical and manufacturing processes, 10) working at speeds dictated by machinery, 11) repetition of identical tasks, and 12) repetitive work. The first principal component was used as the weight for calculating the RTI for each occupation. The US ONET data version used was 27.3 (released in March 2023), and the jobtag data version was 3.01.01 (released in October 2022).

It should be noted that when comparing Japan and the US using RTIs calculated from combined data, a tendency for bias was observed—RTI scores for Japanese occupations were generally higher. Consequently, when calculating the RTI, the indicators were standardized separately for each country (with a mean value of 0 and a standard deviation of 1), and weights were estimated accordingly for each nation (see Figure B). This bias is likely due to differences in the response tendencies of Japanese and American workers to the same survey items; thus, caution is required when interpreting the comparative results.

Figure B: Components and weights of the Routine Task Intensity (RTI) based on Japan-U.S. O-NET data

Task content measure	US O*NET ID	Task items	Weight (US O*NET)	Jobtag ID	Weight (Jobtag)
Non-routine cognitive analytical	4.A.2.a.4	Analyzing data/information	-0.317	IPD_04_10_009	-0.398
	4.A.2.b.2	Thinking creatively	-0.320	IPD_04_10_011	-0.330
	4.A.4.a.1	Interpreting information for others	-0.367	IPD_04_10_025	-0.400
Non-routine cognitive interpersonal	4.A.4.a.4	Establishing and maintaining personal relationships	-0.342	IPD_04_10_028	-0.371
	4.A.4.b.4	Guiding, directing and motivating subordinates	-0.269	IPD_04_10_036	-0.342
	4.A.4.b.5	Coaching/developing others	-0.294	IPD_04_10_037	-0.363
Routine cognitive	4.C.3.b.7	The importance of repeating the same tasks	0.152	IPD_04_05_011	0.007
	4.C.3.b.4	The importance of being exact or accurate	0.057	IPD_04_05_010	-0.199
	4.C.3.b.8	Freedom to determine tasks, priorities or goals (inverse)	-0.287	IPD_04_05_022	-0.205
Routine manual	4.C.3.d.3	Pace determined by the speed of equipment	0.313	IPD_04_05_012	-0.001
	4.A.3.a.3	Controlling machines and processes	0.274	IPD_04_10_018	0.010
	4.C.2.d.1.i	Spending time making repetitive motions	0.324	IPD_04_05_019	0.324

Source: Mitsubishi Research Institute, Inc.

Appendix C: Labor mobility simulations based on viability and desirability

To shed light on the future of the labor market, we conducted simulations based on the labor supply-and-demand mismatch framework, spanning 171 industries and 233 professions in 2035—details are in Appendix A. Simulations examine the viability and desirability of workforce mobility with a view to rectifying the mismatch.

For viability, we considered three key variables: 1) job similarity, with metrics drawn from Lightcast data for skill sets and O*NET data for job responsibilities, knowledge, and areas of interest, 2) educational equivalence, ensuring no significant gaps in the level of educational attainment, and 3) labor practice conformity, ascertaining that demographics like gender ratio, average age, and the rate of non-regular employment are comparable.

For desirability, we considered two key variables:1) long-term skill requirements, considering the human resource demand likely to arise from digital transformation, globalization, and the semiconductor-industry revival, and 2) wage and non-routine nature of jobs, with the stipulation that job quality, as measured by the level of non-routine tasks, should ideally improve post-mobility.

The simulations operate iteratively, reallocating workforce from surplus to deficit categories within the 171 industries and 233 professions. The methodology is as follows:

Step 1: Initial adjustments for internal reskilling, essentially subtracting the mismatch resolved within organizations without job changes, particularly in the context of digital transformation.

Step 2: Identifying deficit categories by non-routine intensity and employee numbers, prioritizing these categories for the next stage of workforce mobility simulation.

Step 3: Pinpointing the originating categories for workforce mobility based on the five aforementioned criteria, ranking them and accordingly selecting the most suitable ones.

Step 4: Executing the workforce mobility from the most viable and desirable originating categories to the deficit categories, with a ceiling of 20% of the employment in the originating category.

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[1] Cabinet Office, "Basic Policy on Economic and Fiscal Management and Reform 2023." URL: https://www5.cao.go.jp/keizai-shimon/kaigi/cabinet/honebuto/2023/decision0616.html (Accessed September 8, 2023)

[2] For details on the FLAP Cycle, refer to the following URL (available in Japanese only): https://www.mri.co.jp/frontline/02_hr.html

[3] Japan Institute for Labour Policy and Training (JILPT), "Estimates of Labor Supply and Demand: Future Estimates Based on the Baseline Labor Participation Gradual Advancement Scenario (Fiscal Year 2018 Version)," March 2019. The scenario assumes modest economic growth and increased labor market participation from youth, women, and the elderly, given certain economic and employment policies. URL: https://www.jil.go.jp/institute/siryo/2019/209.html (Accessed September 8, 2023)

[4] For details on the Carbon Neutral Achievement Scenario, refer to Mitsubishi Research Institute, "Report on Transition to Carbon Neutrality: Capital Flows, Resource Circulation, and International Collaboration Are Key," August 2023.
URL: https://www.mri.co.jp/en/knowledge/insight/20230825.html

[5] The labor demand estimates targeted here are for three industries: semiconductor device manufacturing, integrated circuit manufacturing, and semiconductor manufacturing equipment. While the semiconductor industry broadly includes materials, memory media, related services, etc., the focus here is solely on semiconductor manufacturing.

[6] For details on the task portfolio, refer to Mitsubishi Research Institute, "Human Capital Strategies for the Post-COVID - Toward Realizing the FLAP Cycle," April 2021 (available in Japanese only), p. 16. URL: https://www.mri.co.jp/knowledge/insight/dia6ou000002 wagv-att/er20210428pec_all.pdf

[7] Digital certification of knowledge, skills, and experience. Many open badges are issued by universities, certification organizations, and global IT companies, mainly in Europe and the United States, and a variety of organizations are issuing them in Japan. As an international standard, open badges can be a digital marketing tool to increase the number of examinees and students by making their qualifications and learning visible.

[8] World Economic Forum, "Building a Common Language for Skills at Work: A Global Taxonomy," Jan 2021. URL: https://www.weforum.org/reports/building-a-common-language-for-skills-at-work-a-global-taxonomy (Accessed September 8, 2023)

[9] World Economic Forum, "Putting Skills First: A Framework for Action," May 2023. URL: https://www.weforum.org/whitepapers/putting-skills-first-a-framework-for-action (Accessed September 8, 2023)

[10] OECD, "Burning Glass Technologies' data use in policy-relevant analysis: An occupation-level assessment," May 2021. URL: https://www.oecd-ilibrary.org/science-and-technology/burning-glass-technologies-data-use-in-policy-relevant-analysis_cd75c3e7-en (Accessed September 8, 2023)

[11] For example, labor market analyses by the OECD and the World Economic Forum's annual "Future of Jobs" report use job posting data from Lightcast. Research institutions like the National Bureau of Economic Research (NBER) also publish peer-reviewed papers using Lightcast's job posting data.

[12] For example, Deloitte, "The skills-based organizations: A new operating model for work and the workforce," February 2023, defines 'skills' broadly as "hard" or technical skills (such as coding, data analysis, and accounting); human capabilities or human skills (such as critical thinking and emotional intelligence); and potential (including latent qualities, abilities, or adjacent skills that may be developed and lead to future success).

[13] Here, the study examines the possibility of resolving the mismatch of 4.8 million people based on 'viability' and 'desirability,' as shown in Figure 2 on page 3. For details, refer to "Appendix C: Labor mobility simulations based on 'Viability' and 'Desirability'."

[14] Mitsubishi Research Institute, "Report on Transition to Carbon Neutrality: Capital Flows, Resource Circulation, and International Collaboration Are Key," August 2023. URL: https://www.mri.co.jp/en/knowledge/insight/20230825.html

[15] For example, on the educational platform Zillearn (https://www.zillearn.com), individuals can create an account and input their existing skills and target jobs. The platform then recommends various educational content to acquire lacking skills. SkillsFuture Singapore is a partner, and skill-related data is provided by Lightcast.

[16] Mitsubishi Research Institute, "Recommending Career Shifts for the DX & GX Era," July 2022 (available in Japanese only). URL: https://www.mri.co.jp/knowledge/insight/20220706.html

[17] Tomomi Miyashita, "Human capital management starts from the local economy: talent and reskilling strategies in semiconductor industry," MRI Economic Review, June 2023 (available in Japanese only). URL: https://www.mri.co.jp/knowledge/insight/20230621.html