Xymax Research Institute
TOPIC REPORT

Estimating the Replaceability of Occupations by Generative AI and Robots

To Solve the Labor Shortage Problem (Vol. 12)

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Introduction

Regarding the issue of labor shortages, Xymax Research Institute has pointed out that the shortage of non-desk workers is at the heart of the problem. One reason we have focused on non-desk work is that, while it has long been pointed out that advances in generative AI could reduce the demand for desk work, it has been believed that occupations in the non-desk work sector are difficult to automate, and that the demand for human labor in these areas will be sustained well into the future.

In recent years, however, technological advancements have not been limited to the digital realm of generative AI but have also spread to the field of robotics. Although robotics technology itself has existed for some time, its scope of application has expanded in recent years through integration with AI technology. At the same time, against the backdrop of labor shortages in non-clerical roles and rising labor costs, the economic viability of automation is also increasing. These developments have the potential to bring about changes even in areas where automation was previously considered difficult.

A wealth of research regarding the impact of generative AI on jobs and employment has been accumulated in Japan and abroad. On the other hand, analyses that examine the impact of robotics within a similar framework are still limited. This report examines the extent to which, respectively, generative AI and robotics can replace or automate human work.

Chapter 1 explains the data used in the analysis and the analytical methods employed.

Chapter 2 estimates the replaceability of each task across the 427 occupations included in the analysis by generative AI*1 and robots based on the current state of technology. For occupations in which generative AI or robots can handle the majority of tasks, the demand for human labor may decrease in the future.

In Chapter 3, we analyze occupations where labor supply and demand may remain tight not only currently but also in the future. To do so, we consider the jobs-to-applicants ratio for each occupation (i.e., the current degree of labor shortage) alongside the replaceability of each occupation by generative AI and robots (i.e., the potential for future labor demand replacement). Even occupations currently facing severe labor shortages are expected to see an easing of supply and demand as replacement by technology progresses. Conversely, if replacement does not advance, supply and demand pressures may intensify further, potentially leading to rising wage levels.

Given that labor shortage conditions may change between the present and the future, a quantitative assessment of replaceability is considered effective for identifying occupations likely to face tight supply and demand in the future and for considering proactive countermeasures.

*1 For convenience, this report uses the term "generative AI," but the analysis calculates the replacement potential of LLMs (large language models).

1. Analytical Methodology

Drawing on prior research by the Daiwa Institute of Research,*2 we assessed the degree to which the tasks that make up a given occupation can be replaced by generative AI or robots (i.e., the proportion of work currently performed by humans that can be replaced by technology), using Google's generative AI, Gemini 2.5 Flash.

We began the procedure by evaluating the replaceability of each task on a three-tier scale (see box below), quantifying the results by assigning a value of 0 for low replaceability, 0.5 for medium, and 1 for high. We then applied weights based on the importance and implementation rate*3 of each task within each occupation to calculate the impact at the task level. These were aggregated by occupation, and a replaceability index for each occupation was derived using a weighted average. In other words, this index shows "the proportion of a given occupation's work that can be replaced by technology."

*2 Daiwa Institute of Research. (2023). The Impact of Generative AI on Japan's Labor Market (Part 2)
*3 The implementation rate is an indicator of the percentage of people in that occupation who generally perform that task. This analysis does not take into account the proportion of working hours spent performing that task.

[Evaluation of the Impact of LLMs (Large Language Models)]
E0 (Low): Difficult to replace (non-verbal, site-dependent, judgment-intensive work)
E1 (Medium): Partially replaceable (assistance, drafting, classification)
E2 (High): Replaceable with current technology (work completed with text generation, summarization, classification, etc.)
Evaluation criteria: Whether the task is centered on language processing (text/information processing); the presence of processes that LLMs can handle directly; the extent to which human judgment is required

[Evaluation of the Impact of Robotics]
R0 (Low): Difficult to automate (non-routine, flexible response, interpersonal work)
R1 (Medium): Partially supportable (transportation, assistance, semi-automated)
R2 (High): Can be automated with current technology (routine, repetitive, fixed environment work)
Evaluation criteria: Routine/repetitive nature of tasks; structured environment (e.g., factories, warehouses); feasibility of implementation with existing technology

For example, among the 15 tasks that make up the "trading company sales" occupation, "preparing reports on marketing activities" was rated E2 (replaceable by generative AI), while "negotiating with suppliers" and "taking measures to secure receivables" were rated E0 (difficult to replace). "Inventory management" was rated R2 (can be automated by robots), "arranging the transport and delivery of goods" was rated R1 (partially supportable by robots), and other tasks were rated R0 (difficult to automate). In this way, the index is calculated by aggregating differences in replaceability on a task-by-task basis, rather than for the occupation as a whole.

The data used was from the "Occupational Information Database Quantitative Downloadable Data version 6.01" compiled by the Japan Institute for Labour Policy and Training (JILPT). See the end of this document for a more detailed description of the analytical methodology.

This index is based solely on an evaluation of the extent to which the occupation can be replaced by technology. It does not directly indicate the feasibility of actual implementation or the timing of widespread adoption. Factors such as cost, institutional frameworks, safety, and the workplace environment may influence actual implementation.

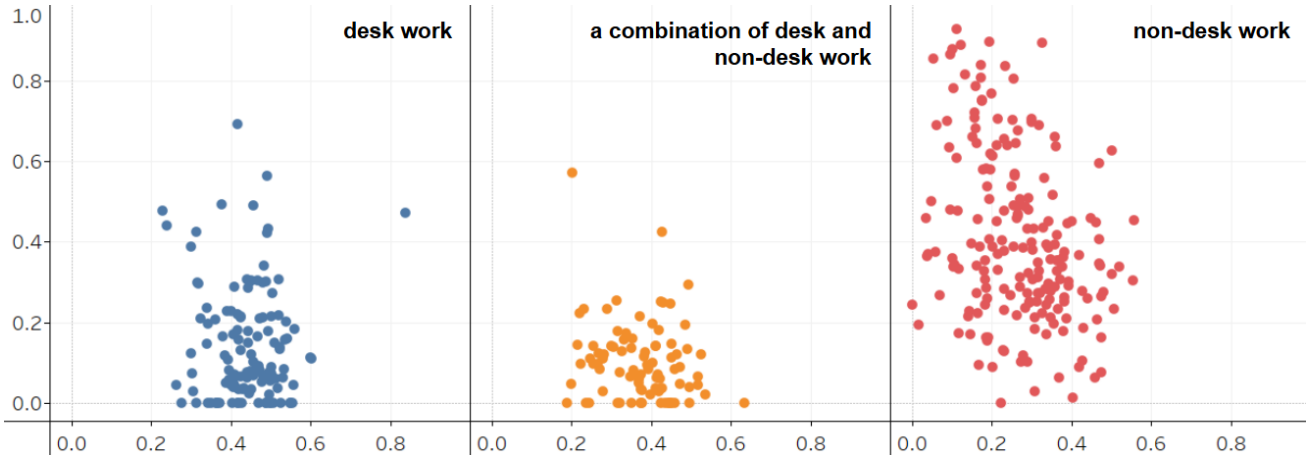
2. Replaceability of Occupations by Generative AI and Robots

This chapter provides an overview of the estimation results for each occupation. The average values for the 427 occupations analyzed were 0.3452 for generative AI replaceability and 0.2582 for robot replaceability.

Figure 1 plots each occupation with generative AI replaceability on the horizontal axis and robot replaceability on the vertical axis and then classifies them into three categories: desk work, a combination of desk and non-desk work, and non-desk work. Comparing the distributions across these categories, the "non-desk work" category contains many occupations with relatively high robot replaceability, while their generative AI replaceability is concentrated in the range of 0.5 or below. In contrast, for desk work and a combination of desk and non-desk work, the likelihood of replacement by generative AI is relatively high and is widely distributed in the range of 0.2 or higher.

This suggests that generative AI and robots each correspond to different job characteristics, and their potential for replacement is complementary. Furthermore, the number of occupations where the potential for replacement by both technologies is high is limited; it can be said that, at present, there are few technologies capable of replacing both information processing and physical labor in an integrated manner.

Figure 1: Distribution of Robot Replaceability and Generative AI Replaceability – By Occupation



When examined by occupation, those that are highly replaceable by generative AI included Data Entry Clerk, Interpreter, and National Civil Servant (Administrative) (Figure 2).

While many of the top 20 occupations are desk jobs centered on routine and repetitive tasks, a certain degree of replaceability was also indicated for highly specialized professions such as Sociological Researcher, IT Consultant, and Financial Planner. Occupations involving information processing, analysis, and document creation tend to be particularly susceptible to the impact of generative AI.

The impact extends to some interpersonal service occupations (such as Travel Agency Counter Staff and Dietitian) and non-desk jobs (such as Amusement Park Staff and Marine Engineer)—fields where automation was previously considered limited—suggesting the broad scope of generative AI's application.

Figure 2: Ranking of Occupations Highly Replaceable by Generative AI

Ranking	Occupation	**Generative AI Replaceability**	(Reference) Robot Replaceability
1	Data Entry Clerk	**0.8370**	0.4713
2	Interpreter	**0.6351**	0.0000
3	National Civil Servant (Administrative)	**0.6013**	0.1094
4	Call Center Operator	**0.6005**	0.1115
5	Sociological Researcher	**0.5950**	0.0000
6	Nonferrous Metallurgy Engineer	**0.5589**	0.1817
7	Amusement Park Staff	**0.5562**	0.4534
8	Independent Financial Advisor (IFA)	**0.5557**	0.0436
9	Marine Engineer	**0.5547**	0.3043
10	IT Consultant	**0.5543**	0.0000
11	Financial Planner	**0.5488**	0.0000
12	Programmer	**0.5480**	0.0000
13	Tax Officer	**0.5397**	0.1604
14	Travel Agency Counter Staff	**0.5371**	0.2001
15	Intellectual Property Coordinator	**0.5355**	0.0211
16	Civil Design Engineer	**0.5348**	0.1576
17	Mail Order Customer Service Clerk	**0.5343**	0.0836
18	Product Planning and Development Specialist (Chain Stores)	**0.5312**	0.0619
19	Dietitian	**0.5253**	0.1190
20	Data Engineer	**0.5247**	0.0000

Source: Created by Xymax Research Institute by processing the "Occupational Information Database Quantitative Downloadable Data version 6.01" compiled by the Japan Institute for Labour Policy and Training (JILPT), downloaded from the occupational information website "job tag" on March 13, 2026 (https://shigoto.mhlw.go.jp/User/download).

Occupations that are highly replaceable by robots include Sake Brewer, Tire Manufacturing Worker, and Packaging Worker; many of the top 20 occupations were non-desk jobs, particularly those involved in processing and production processes within the food, materials, and manufacturing industries (Figure 3).

These occupations involve many repetitive tasks that are easy to standardize. The fact that automation and mechanization are already well underway was cited as the reason for their high ranking. On the other hand, inspection and operator roles also ranked high, suggesting that the wave of automation is extending beyond simple tasks to include parts of process management and quality control. Overall, robots are having a strong impact in areas involving physical labor and have the potential to alter the structure of labor demand in the manufacturing sector.

Furthermore, although they did not make the top 20, it was found that even among office-based jobs, occupations such as IT Device Setup Technician (robot replaceability: 0.6928) and Shipping and Receiving Clerk (robot replaceability: 0.5632) are highly replaceable by robots.

Figure 3: Ranking of Occupations Highly Replaceable by Robots

Ranking	Occupation	(Reference) Generative AI Replaceability	**Robot Replaceability**
1	Sake Brewer	0.1103	**0.9297**
2	Tire Manufacturing Worker	0.1940	**0.8968**
3	Packaging Worker	0.3265	**0.8952**
4	Dairy Products Manufacturing Worker	0.1229	**0.8900**
5	Tofu Manufacturing Worker/Tofu Maker	0.1001	**0.8802**
6	Processed Seafood Products Manufacturing Worker	0.0941	**0.8668**
7	Dyeing Worker/Dyeing Machine Operator	0.0517	**0.8554**
8	Canned, Bottled, and Retort Food Manufacturing Worker	0.1717	**0.8391**
9	Electronics Assembler	0.2338	**0.8360**
10	Bookbinding Machine Operator	0.1316	**0.8157**
11	Industrial Product Inspector	0.1724	**0.8075**
12	Paper Container Manufacturing Worker	0.2544	**0.8049**
13	Frozen Food Manufacturing Worker	0.1601	**0.7878**
14	Pickled Vegetable Manufacturing Worker	0.1030	**0.7832**
15	Pharmaceutical Manufacturing Worker	0.1987	**0.7690**
16	Wood Products Manufacturing Worker	0.1749	**0.7518**
17	Foundry Worker/Foundry Machine Operator	0.1745	**0.7497**
18	Ham, Sausage, and Bacon Manufacturing Worker	0.1559	**0.7204**
19	Food Products Inspector	0.1567	**0.7093**
20	Boiler Operator	0.2988	**0.7065**

Source: Created by Xymax Research Institute by processing the "Occupational Information Database Quantitative Downloadable Data version 6.01" compiled by the Japan Institute for Labour Policy and Training (JILPT), downloaded from the occupational information website "job tag" on March 13, 2026 (https://shigoto.mhlw.go.jp/User/download).

3. Future Labor Demand as Seen Through the Jobs-to-Applicants Ratio

In Chapter 3, we analyzed occupations where labor supply and demand may remain tight not only currently but also in the future by combining the jobs-to-applicants ratio for each occupation (i.e., the current degree of labor shortage) with the replaceability of each occupation by generative AI and robots (i.e., the extent to which labor demand may change in the future).

Figures 4 and 5 are scatter plots showing each occupation, with the vertical axis representing the jobs-to-applicants ratio as of January 2026 and the horizontal axis representing the replaceability by generative AI and robots. The simple average jobs-to-applicants ratio for the 427 occupations was 1.99.*4

*4 The jobs-to-applicants ratio for January 2026 (nationwide total) was 1.18 but note that this value was calculated by dividing the total number of effective job openings nationwide by the total number of effective job seekers and thus differs from the simple average by occupation shown here.

The scatter plot confirms that, for both generative AI and robots, only a limited number of occupations are located in the upper-right quadrant (where the jobs-to-applicants ratio and replaceability are high). In other words, this analysis did not identify many occupations where labor shortages are currently severe, yet replacement by technology is likely to proceed rapidly. The three occupations—Civil Design Engineer, Formwork Carpenter, and Reinforcing Ironworker—are exceptions because their replaceability exceeds 0.5. The use of technology is expected to alleviate labor shortages in these fields.

On the other hand, a certain number of occupations are located in the upper-left quadrant (where the jobs-to-applicants ratio is high, but replaceability is low). These occupations depend heavily on human labor both currently and in the future, making it highly likely that the labor supply and demand will remain tight.

Figure 4: Distribution of Jobs-to-Applicants Ratio (Vertical Axis) and Generative AI Replaceability (Horizontal Axis) – By Occupation

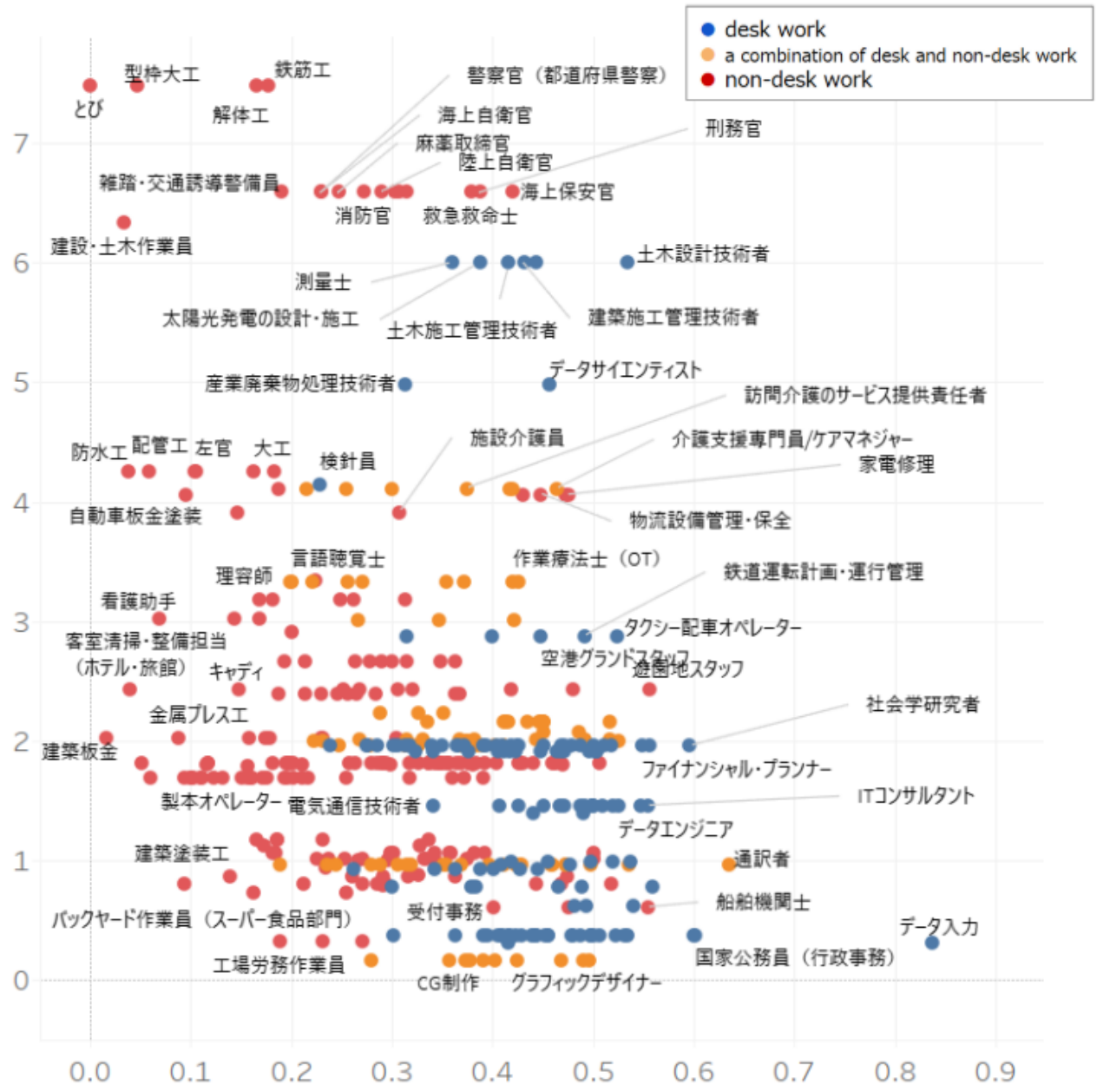
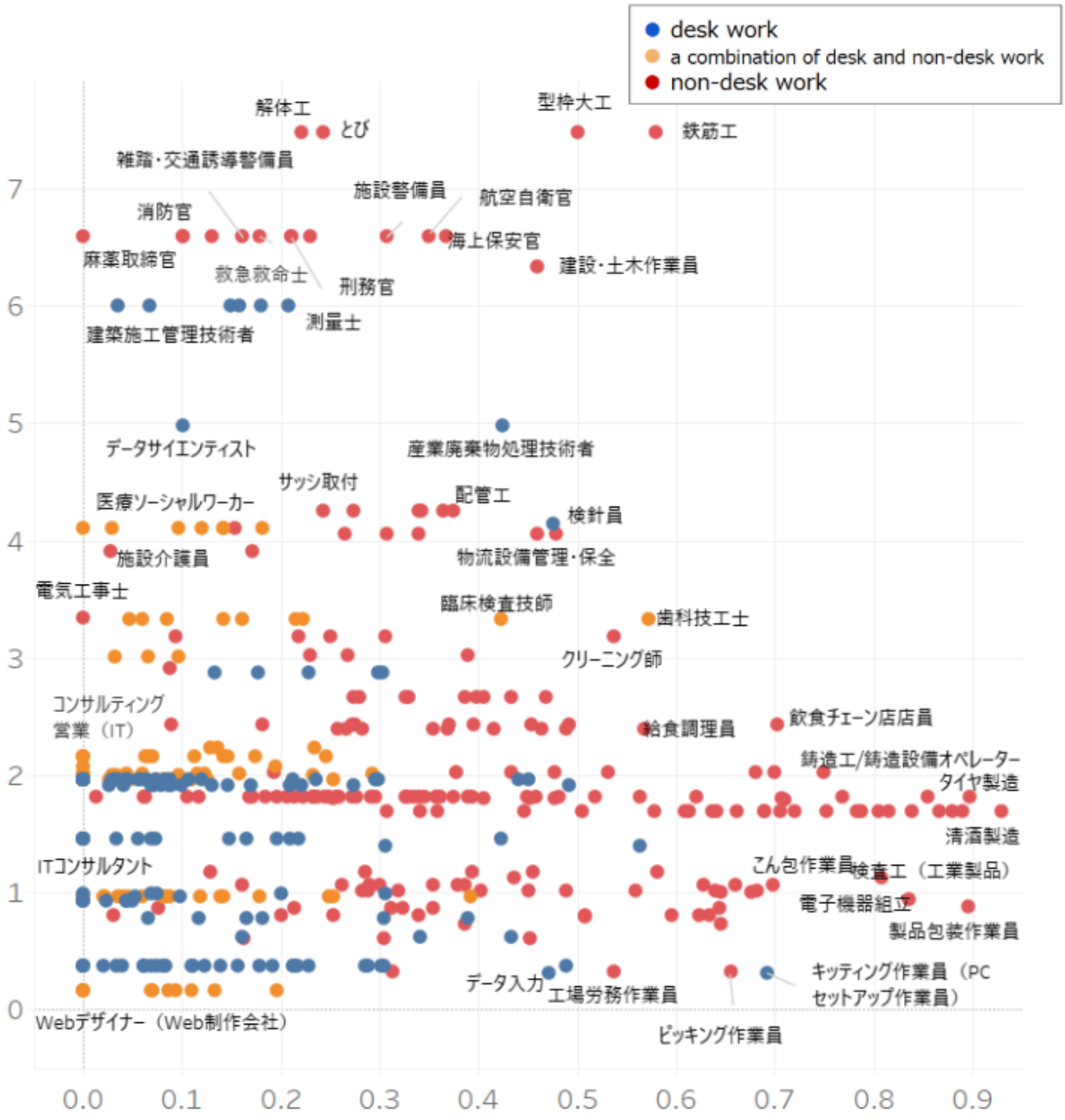


Figure 5: Distribution of Jobs-to-Applicants Ratio (Vertical Axis) and Robot Replaceability (Horizontal Axis) – By Occupation



Figures 6 and 7 show a selection of specific occupations. Occupations with a high jobs-to-applicants ratio and a low replaceability by either generative AI or robots (highlighted in yellow in the figures) include security-related professions such as Police Officer, Maritime Self-Defense Force Personnel, Narcotics Agent, Firefighter, and Ground Self-Defense Force Personnel, as well as Demolition Worker, Scaffolder, and Traffic and Crowd Control Security Guard.

These occupations will likely remain difficult to replace with technology in the future, and labor supply and demand will likely become even tighter. Furthermore, many of these are essential jobs involved in maintaining social infrastructure, and a labor shortage in these fields would have significant societal impacts. Therefore, for these occupations, it is necessary not only to implement measures to secure personnel, such as improving working conditions, but also to identify areas where even a portion of tasks can be automated or made less labor-intensive, and to progressively advance the utilization of technology.

Figure 6: Distribution of Jobs-to-Applicants Ratio and Generative AI Replaceability (Excerpt) – By Occupation

	Generative AI Replaceability: Low (0.3 or Lower)	Generative AI Replaceability: High (0.5 or Higher)
Jobs-to Applicants Ratio: High (6 or Higher)	**Labor shortages exist, but replaceability by generative AI is limited** • **Scaffolder** • Construction and Civil Engineering Worker • Formwork Carpenter • **Demolition Worker** • Reinforcing Ironworker • **Traffic and Crowd Control Security Guard** • **Police Officer (Prefectural Police)** • **Maritime Self-Defense Force Personnel** • **Narcotics Agent** • **Firefighter** • **Ground Self-Defense Force Personnel**	**Labor shortages exist, but replacement can be expected** • Civil Design Engineer
Jobs-to-Applicants Ratio: Low (1 or Lower)	**Difficult to replace with generative AI, but labor shortage is moderate** • Automobile Assembly Worker • Building Painter • Forklift Operator • School Counselor • Factory Laborer • Control Panel Assembly Worker • Order Picker • Electronics Assembler and more	**Potential decline in labor demand** • Data Entry Clerk • Interpreter • National Civil Servant (Administrative) • Call Center Operator • Nonferrous Metallurgy Engineer • Marine Engineer • Tax Officer • Travel Agency Counter Staff and more

Figure 7: Distribution of Jobs-to-Applicants Ratio and Robot Replaceability (Excerpt) – By Occupation

	Robot Replaceability: Low (0.3 or Lower)	Robot Replaceability: High (0.5 or Higher)
Jobs-to Applicants Ratio: High (6 or Higher)	**Labor shortages exist, but replaceability by robots is limited** • **Narcotics Agent** • Architectural Construction Project Manager • Solar Power System Design and Installation Technician • **Firefighter** • **Ground Self-Defense Force Personnel** • **Police Officer (Prefectural Police)** • Architectural Design Engineer • Civil Design Engineer • **Traffic and Crowd Control Security Guard** • Paramedic • Civil Construction Project Manager • Surveyor • Correctional Officer • Road Patrol Officer • **Demolition Worker** • **Maritime Self-Defense Force Personnel** • **Scaffolder**	**Labor shortages exist, but replacement can be expected** • Formwork Carpenter • Reinforcing Ironworker
Jobs-to-Applicants Ratio: Low (1 or Lower)	**Difficult to replace with robots, but labor shortage is moderate** • Graphic Designer • Web Designer (Web Production Company) • Advertising Designer • Planning and Research Specialist • Internal Auditor • IR and Public Relations Specialist • Event Planner and Coordinator • Human Resources Manager and more	**Potential decline in labor demand** • Packaging Workers • Electronics Assembler • IT Device Setup Technician • Plating Worker • Order Picker • Forklift Operator • Steel Production Operator • Parking Facility Manager and more

Figure 8 presents a ranking of occupations—based on these estimates—where the combined replaceability by generative AI and robots is 0.4 or lower (relatively low within the overall distribution), sorted by jobs-to-applicants ratio in descending order. Occupations with the same jobs-to-applicants ratio are ranked in order of the lowest combined replaceability. Current annual income is listed as a reference value. This indicates occupations that are difficult to replace with current technology but that are experiencing severe labor shortages. This information can be used as a reference to estimate the level of pressure for wage increases driven by tight supply and demand.

As a result, in addition to skilled trades such as scaffolders and demolition workers, interpersonal and on-site occupations such as police officers, firefighters, and care workers ranked high on the list. These occupations share the common characteristic of being non-routine, physically demanding, and involving a significant amount of decision-making, making them difficult to replace with technology.

However, the impact on wages varies depending on the area to which the occupation belongs. For skilled trades in the private sector, tight labor supply and demand is likely to exert direct pressure for improved working conditions, leading to the ability to recruit personnel. Conversely, in occupations that are highly public-service-oriented, such as police work, firefighting, and caregiving, wage levels are strongly constrained by institutional frameworks and compensation systems, making it difficult for tight supply and demand to be immediately reflected in wages. In these public-sector areas, efforts to improve working conditions through measures such as institutional reforms will likely be required in the future.

Figure 8: Ranking of Occupations Likely to Experience Increased Wage Pressure

Ranking	Occupation	Jobs-to-Applicants Ratio (Jan. 2026)	Generative AI Replaceabilit	Robot Replaceabilit	Annual Income (Yen)
1	Scaffolder	7.48	0.0000	0.2429	4,145,100
2	Demolition Worker	7.48	0.1645	0.2211	4,145,100
3	Narcotics Agent	6.59	0.2470	0.0000	(Undisclosed)
4	Traffic and Crowd Control Security Guard	6.59	0.1900	0.1611	3,352,600
5	Police Officer (Prefectural Police)	6.59	0.2290	0.1303	(Undisclosed)
6	Firefighter	6.59	0.2723	0.1013	3,352,600
7	Ground Self-Defense Force Personnel	6.59	0.2895	0.1014	(Undisclosed)
8	Housekeeper	4.11	0.1877	0.1530	4,026,700
9	Child Welfare Worker	4.11	0.2543	0.0967	4,416,600
10	Senior Care Facility Counselor	4.11	0.2146	0.1425	4,416,600
11	Home Care Service Manager	4.11	0.3743	0.0000	4,413,400
12	Home Care Worker	3.91	0.1459	0.1707	3,818,900
13	Care Worker at Long-term Care Facility	3.91	0.3067	0.0278	3,880,200
14	Electrician	3.34	0.2238	0.0000	6,281,100
15	Speech-Language Pathologist	3.33	0.1992	0.0465	4,436,000
16	Physical Therapist (PT)	3.33	0.2711	0.0842	4,436,000
17	Orthoptist	3.33	0.2557	0.1412	4,436,000
18	Nail Technician	3.18	0.1682	0.0940	3,538,700
19	Nursing Assistant	3.02	0.0679	0.2672	3,370,800
20	Veterinary Nurse	3.02	0.1433	0.2289	3,518,800

Source: Created by Xymax Research Institute by processing the Ministry of Health, Labour and Welfare's "General Job Placements (Report on Employment Service)" and "Basic Survey on Wage Structure," as well as the "Occupational Information Database Quantitative Downloadable Data version 6.01" compiled by the Japan Institute for Labour Policy and Training (JILPT), downloaded from the occupational information website "job tag" on March 13, 2026 (https://shigoto.mhlw.go.jp/User/download).

Conclusion: Restructure the Division of Roles Between Humans and Technology

The insights gained from this analysis can be summarized into two main points.

First, generative AI and robots address different types of work characteristics, and their potential for replacement exists in a complementary relationship. Generative AI strongly influences intellectual tasks such as administrative work, analysis, and design, while robots have a significant impact on physical and repetitive tasks. At present, there are only a limited number of occupations where the replaceability by both is high simultaneously. However, it is important to note that this dynamic may change in the future due to technological advancements such as "physical AI," which combines the capabilities of both.

Second, at present, there are almost no occupations identified where labor shortages are severe yet the replaceability by technology is high. This indicates that the situation is not as simple as labor shortages being automatically resolved through the introduction of technology. Therefore, efforts to address labor shortages should not rely solely on the introduction of technology but must be pursued in combination with traditional measures, such as improving working conditions.

Furthermore, during the course of this analysis, it was confirmed that replaceability varies significantly from task to task even within the same occupation. This suggests the need to redesign measures to address labor shortages on a task-by-task basis rather than on an occupation-by-occupation basis. In other words, it may be possible to utilize the limited labor force more efficiently by reallocating it for each task—whether by having people perform the task, replacing the task with technology, or distributing the task to others. While new labor supply mechanisms, such as on-demand work, are becoming more widespread, their use is currently limited to certain industries and cannot yet be considered sufficient in sectors facing severe labor shortages. Going forward, it will be important to redesign work styles based on breaking down and reassigning tasks, including the use of such mechanisms.

In light of the above, this analysis is not a simple debate over whether technology will take away jobs but rather aims to provide insights into the challenge of how to restructure the division of labor between technology and humans amid a worsening labor shortage. We plan to conduct future analyses focusing on the ease of distributing each task to others and to examine the potential for alleviating labor shortages through task reallocation.

Details of the Analytical Methodology

This estimation was conducted using the following procedures, drawing on the estimation methodology outlined in *The Impact of Generative AI on Japan's Labor Market (Part 2)* (Daiwa Institute of Research, 2023).

(1) Task-level evaluation: We extracted task descriptions for each occupation included in this analysis and used Google's generative AI, Gemini 2.5 Flash, to evaluate the replaceability of each task by generative AI and by robots. Evaluations were assigned categorical values, which were then quantified in the analysis by assigning 0 to "low," 0.5 to "medium," and 1 to "high."

(2) Task weighting: For each task, we combined information on task importance and implementation rate to reflect the proportion that task accounts for within the occupation as a whole. The impact per task was

calculated by multiplying the task's importance by its implementation rate for both the generative AI and robot replacement assessments. This allowed for an evaluation that considered not merely whether replaceable tasks existed, but also the relative weight of each task within the occupation as a whole.

(3) Occupation-level aggregation: We calculated the replaceability by generative AI and robots for each occupation by summing the impact scores calculated on a per-task basis by occupation and dividing it by the total weight of all tasks. These indicators range from 0 to 1; a higher value indicates a higher proportion of tasks within that occupation that can be performed by generative AI or robots. Note that these indicators are calculated as a weighted average of "evaluation value × task importance × task implementation rate."

Data source: Created by Xymax Research Institute by processing the "Occupational Information Database Quantitative Downloadable Data version 6.01" compiled by the Japan Institute for Labour Policy and Training (JILPT), downloaded from the occupational information website "job tag" on March 13, 2026 (https://shigoto.mhlw.go.jp/User/download).

Data used: This analysis utilized occupational data (descriptions of tasks associated with each occupation, task importance, and task implementation rates) published on the occupational information website "job tag." Task importance is an indicator of how important a given task is within an occupation, while the implementation rate is an indicator of the percentage of people in that occupation who generally perform that task.

For further inquiries, please contact below:

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