International Labour Organization

Room document*: 18

The International Standard Classification of Occupations (ISCO-08): Recent developments and revision

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* This document was not formally edited

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Abbreviations and acronyms

ANZSCO	Australian and New Zealand Statistical Classification of Occupations, 2021
Canadian NOC	Canada, National Occupation Classification, 2021
FAO	Food and Agriculture Organization of the UN (FAO).
ICLS	International Conference of Labour Statisticians
ILO	International Labour Organization
ILO- ROAS	ILO Regional Office of Arab States
ICSE-18	International Classification of Status in Employment, 2018
ISCED	International Standard Classification of Education, UNESCO
ISCO	International Standard Classification of Occupations
KSCO	Korea, Korean Statistical Classification of Occupation, 2017
LFS	Labour Force Survey
ML	Machine Learning
n.e.c	Not elsewhere classified (in reference to categories in ISCO or NOC)
NEF/NQF	National Educational Frameworks/ National Qualification framework
NOC	National Occupation Classification
O*NET	Occupational Information Network
POC	Proof of Concept
ROA- CBS	The Netherlands, Occupations Classification ROA-CBS, 2014
SINCO	Mexico, Systema Nacional de Clasificación de Ocupaciones, 2019
SSOC	Singapore, Singapore Standard Occupational Classification, 2020
SWG	Sub Working Group of the Technical Working Group on ISCO-08 revision
SWG1	Improve the structure in ISCO (in relation to ISCO-08 TWG)
SWG2	Improve the group definitions, and notes in ISCO (in relation to ISCO-08 TWG)
SWG3	Modernization of ISCO (in relation to ISCO-08 TWG)
TWG	Technical Working Group on ISCO-08 revision
UN	United Nations
UK SOC	United Kingdom, Standard Occupation Classification, 2020
US SOC	United States of America, Standard Occupational Classification, 2018
WHO	World Health Organization

1. Introduction and background[1]

1. The current version of the International Standard Classification of Occupations is known as ISCO-08. It is a four-level hierarchically structured classification with the aim of providing a comprehensive framework for classifying all jobs in the world. The system encompasses 436 unit groups, which are organized and aggregated into 130 minor groups, 43 sub-major groups, and 10 major groups based on their similarity in terms of the skill level and skill specialization required for the jobs.

2. ISCO-08 provides:

   a) a basis for the international reporting, comparison and exchange of statistical and administrative information about occupations;
   b) a useful model for the development of national and regional classifications of occupations; and
   c) a system that can be used directly in countries that have not developed their own national occupational classification (NOC).

3. ISCO-08 was adopted through a resolution of a Tripartite Meeting of Experts on Labour Statistics in December 2007 and subsequently endorsed by the Governing Body of the ILO in March 2008. ISCO-08 is part of the International Family of Classifications[2] and has been recognized and fully supported by the international community as a widely accepted standard for international labour statistics.

4. Many countries have either directly adopted ISCO-08, or designed or adapted their NOC in line with it or have developed crosswalks enabling them to report data according to ISCO-08 for enhanced comparability.

5. As the ISCO custodian, the ILO provides capacity building, training and guidance on its use and implementation to various users, including countries, agencies and others. The office recently developed useful material and resources to support the use and implementation of ISCO-08.

6. Although feedback regarding the usefulness of ISCO-08 has been predominantly positive, various issues have arisen during its implementation, mainly due to ongoing technological advancement and changes within the world of work. As a result, concerns have been raised about the need to revise and update various aspects of the classification. For example, some groups have been viewed as inadequately represented within the classification or necessitating detailed categories. Additionally, users have noted blurred boundaries between existing categories. Furthermore, the measurement and use of skill level as a classification criterion, as well as the changing skill levels of certain occupations within ISCO-08, were considered major concerns for users of the classification. These and other issues have had a significant impact on the effectiveness of the classification, including imposing limitations on analysis and its usefulness in various operations.

7. The case to revise ISCO-08 was discussed at the 19th and 20th International Conference of Labour Statisticians (ICLS). It was recognized that tackling issues like the problem of skill levels and updating the ISCO structure would require major structural modifications to the classification. Such work could start after the 20th ICLS so that ISCO remains relevant and could be used in the 2030 round of housing and population censuses.

8. Following the 20th ICLS, the office continued its efforts to gather and seek feedback on ISCO-08 from various users, including countries, professional associations, international organizations and others. To support the ILO in revising ISCO-08 in advance of the 2030 round of housing and population censuses, a Technical Working Group (TWG) was established in June 2021. Since June 2021, the TWG has held several online consultations during which many issues were discussed and proposals to address many of these were made, while the work continues to address another number of problems and concerns in the classification.

9. This room document provides an overview of the recent developments, the support provided to ISCO users, and the progress made in revising the classification. Additionally, it outlines proposed plans for the modernization of ISCO and activities to complete the revision of the classification.

[1] This room document was prepared by Lara Badre, Senior Statistician, ILO Department of Statistics.

[2] See: https://unstats.un.org/unsd/classifications/Family.

2. Support provided to countries and recent developments

10. Many countries have directly used ISCO-08, designed or adapted their NOCs in line with it, or developed crosswalks allowing them to report data according to ISCO-08 to enhance comparability. ISCO-08 has been adopted for use in all European Union (EU) data collections since 2011. Furthermore, a number of regional classifications of occupations have also been designed in line with or based upon ISCO-08.

11. The ILO has been actively supporting countries in the use and implementation of ISCO-08. This effort has involved providing capacity-building and technical assistance to countries such as Armenia, Eswatini, Iraq, Lebanon, Mauritius, Namibia, Qatar, Uganda, Ukraine and Viet Nam.

12. Additionally, the ILO has provided support to another group of countries, to UN and regional agencies, to researchers and other users. This support included advice on using ISCO-08, or coding of occupations in ISCO-08, sharing needed documentation and material, etc.

13. To further assist countries in using and implementing the classification, and based on the request expressed by several users, an 'ISCO-08 companion guide' has been developed. The guide covers various useful topics that were not necessarily or fully discussed in ISCO-08 Volume 1 (ILO, 2012).[3] It covers topics such as the basic requirements of classification of occupations, the conceptual approach used in ISCO-08, the process to adopt or adapt ISCO-08 for national use, including discussions on governance, the needed resources and data sources, the methods for collecting and coding information on occupations, mapping NOC to ISCO-08, etc. The guide is intended to aid in the systematic implementation and use of ISCO-08 in various operations and/or to assist in developing or updating a NOC in line with ISCO-08. The guide draws on lessons learned from the implementation of ISCO-08, feedback received from users, or major difficulties encountered in using ISCO-08 and includes several practical and useful examples derived from various countries practices.

14. In 2021, and as requested by several ISCO users from the Arab region, the ISCO-08 structure was translated into Arabic. It provides a widely accepted terminology to be used by Arabic speaking countries. The work was developed through several online meetings with the support of the ILO Regional Office of Arab States (ILO-ROAS) and the Regional Working Group on Labour Indicators in the Arab Region.

15. Additionally, a new ISCO webpage[4] has been launched in 2022. Content and material from the old ISCO webpage[5] will be gradually transitioned and migrated to the new one as it will undergo regular update and additional material and functions will be added progressively. The page features a basic '*assisted search code*' function using ISCO-08 to facilitate the coding of information on occupations. It also contains useful documentation, such as the ISCO-08 structure and group descriptions in Excel format, to facilitate data and metadata sharing, exchange and integration.

[3] ISCO-08 volume 1 is available at: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_172572.pdf

[4] The page is available at: https://ilostat.ilo.org/resources/concepts-and-definitions/classification-occupation/

[5] The page is available at: https://www.ilo.org/public/english/bureau/stat/isco/isco08/ it will be discontinued over time.

3. Undertaking the revision of ISCO-08 following the 20th ICLS

16. ISCO-08 reflects the occupational patterns of its period and is thus outdated in many areas, mainly following the dynamic nature of the global labour market and the introduction of new technologies in various processes, leading to a structural shift in occupational skills and the emergence of new occupations.

17. In order to keep the classification relevant to the user's needs, the ILO discussed the case to revise ISCO-08 during the 19th and 20th ICLS meetings. Two room documents (ILO, 2013a[6]; ILO, 2018a[7]) summarize the main issues that were gathered based on consultations undertaken in the past with a number of national experts in occupation classification. There was no consensus on a minor ISCO update at the 19th ICLS. The report of the 20th ICLS highlighted 'the need for work to start on the revision of ISCO-08 as soon as possible, through the establishment of an expert working group, so that a revised classification could be in place in time for the 2030 round of national censuses'. (ILO, 2018c) (see § 129).[8]

3.1. Establishing the Technical Working Group (TWG)

18. To support the ILO in revising ISCO-08 in advance of the 2030 round of housing and population censuses, a Technical Working Group (TWG) was established in June 2021. The TWG is composed of representatives of governments, employers, and workers organizations, and observers from international, regional and special agencies. 36 countries are members of the TWG, representing all regions of the world and countries at different stages of economic development and expertise in classifications and the labour market. Annex 1 provides further detail on the composition of the TWG.

19. In July 2022, the TWG was split into three Sub Working Groups (SWGs) namely: *SWG1 'Improve the ISCO structure'* which is chaired by Mexico; *SWG2 'Improve group descriptions and related notes'* which is chaired by Switzerland; and *SWG3 on 'The modernization of ISCO'* which is chaired by New Zealand. Each of these SWGs focuses attention on specific areas or issues in the ISCO. A set of principles and guidelines was formulated and agreed on within each SWG to guide the process of revising the classification.

3.2. Undertaking initial consultations

20. The first meeting of the TWG was held online on June 28-30, 2021. This meeting was followed by a number of online consultations and regular exchange and information-sharing[9] which aimed at discussing and agreeing on the scope, the strategy and the roadmap for the ISCO-08 revision. These consultations were also dedicated to prioritizing the various known issues in the classification and to suggest options and solutions to address some of these, as well as to explore projects to modernize the classification.

21. The TWG agreed on a set of key principles to drive the ISCO revision. For example, all proposed options, solutions, or modifications to address issues in ISCO-08, should be necessary and supported by arguments. They should be based on plausible sources of information and take country practices into account to the extent this is possible. The balance between the need to update ISCO and maintaining comparability with previous statistics produced based on ISCO-08 and ISCO-88 was also among the key principles agreed on within the TWG. Therefore, it was decided to make the necessary adjustments to minimize breaks in the series unless these were unavoidable. Additionally, it was agreed to ensure that ISCO remains globally relevant and inclusive and that recommendations for improvement can be systematically applied by countries. For example, it was decided to avoid proposing changes that will be challenging or irrelevant for most countries to implement,

[6] The document is available at: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/meetingdocument/wcms_221637.pdf
[7] The document is available at: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/meetingdocument/wcms_636056.pdf
[8] The document is available at: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/publication/wcms_651209.pdf
[9] An online password-protected space was created on Confluence for the TWG to collectively collaborate on the revision of ISCO by sharing information and documentation related to ISCO and/or country practices.

such as not creating categories when these are known to be country-specific or when only small numbers of workers are found to be employed in these jobs. Therefore, any further breakdown of categories can be dealt with at the country level as part of the national adaptation process; for example, a 5th level can be considered in national classifications if needed. Unnecessary imbalances in the classification will be avoided by making sure not to dramatically expand or reduce the number of groups in ISCO. It was also decided to maintain major groups unchanged unless this was unavoidable.

22. Additionally, the office shared updates on the progress of the ISCO-08 revision and gathered further feedback from users of the classification, such as by participating in the meetings of the UN Expert Group on International Statistical Classifications. Furthermore, the office participated in the sub-regional meeting organized by Statistical Centre for the Cooperation Council for the Arab Countries of the Gulf (GCC-Stat) in February 2023. This meeting served as a valuable occasion to share information on the progress of work related to the revision of ISCO-08 and collect further issues in the classification. The office also joined a number of working groups involving the use of ISCO or information and statistics on occupations, provided needed support and advice on using ISCO, collected feedback on specific areas of ISCO and improvements needed. Ad-hoc consultations with subject matter experts and agencies were also undertaken on matters related to the use and revision of ISCO, including skills, the use of Machine Learning (ML) and big data, automatic coding of information on occupations and other topics, etc.

3.3. Identifying the types of major issues in ISCO-08

23. The office collected a considerable number of issues in ISCO-08 from a wide range of sources. These issues are kept by the ILO in a log and shared with the TWG through a password-protected online forum. The 20th ICLS's Room Document N.19 (ILO, 2018a) discussed various issues in ISCO-08 that were compiled before the conference. Following the 20th ICLS, the office continued collecting problems and concerns reported by countries, professional associations, working groups and other users of ISCO, in addition to those identified or proposed for improvement by the TWG. Furthermore, as part of the preparations for the 21st ICLS, the office circulated a questionnaire on country practices review, which included a couple of questions on issues and areas of potential improvement of ISCO-08.[10] This approach ensures that all the problems and concerns encountered in implementing ISCO-08 are identified and taken into consideration. Box 1 provides a summary of the main types of identified issues related to ISCO-08 as of July 2023.

▶ Box 1 Main types of issues in ISCO-08

Main issues in relation to the ISCO-08 skill model:

- Measurement and use of skill levels as a classification criterion
- Breadth of Skill Level 2/ Boundary between Skill Levels 2-3
- Revision of skill levels for several unit groups

Alignment of ISCO with recent standards:

- Such as the 19th ICLS resolution I concerning statistics of work, employment and labour underutilization, 20th ICLS Resolution I concerning statistics on work relationships, ISCED-11, etc

Main issues in relation to the ISCO-08 structure, group descriptions and scope:

- Updating the ISCO structure, incorporating new and emerging occupations, further breakdown, or provision of detail for some existing categories and treatment of obsolete categories
- Revision and update of various group descriptions and accompanying notes
- Improving the conceptual clarity for various categories and identifying systematic treatment for these
- Updating the ISCO Index of occupational titles

Main issues in relation to the modernization of ISCO:

- Maintenance and targeted updates of ISCO
- A new presentation of the ISCO structure and the creation of job families or job clusters
- Establishing a research agenda on the future of ISCO

[10] As we draft this room document, it is important to note that the results of this survey are still pending collection and analysis. Consequently, some issues reported by countries might not be properly reflected within this document. So far, we note that some concrete proposals to improve certain groups in ISCO were made by a number of countries and these will be discussed within the TWG.

4. Progress of work and proposals to address several issues in ISCO-08

24. Since June 2021, the TWG has undertaken a number of initial consultations to discuss various issues in ISCO-08, as illustrated in Box 2.

▶ Box 2 Major topics discussed as part of the initial consultations undertaken by the TWG

ISCO-08 revision strategy, scope and key principles

- Discuss and agree on the scope of the revision of ISCO-08, the process, the strategy, the timetable of main activities and the Terms of Reference (TORs) of the TWG
- Review the major principles in ISCO, including the underlying conceptual model of ISCO
- Assessment of known issues in ISCO-08, examine and prioritize them
- Discuss the recommendations derived from the 19th and 20th ICLS meetings
- Discuss a number of suggested major modifications in ISCO: including its skill model, its structure and the modernization of ISCO

Discussions around various issues and groups in ISCO-08

- Align ISCO with recent and related standards (19th, 20th ICLS Resolution I, ISCED-11).
- Examine the need to expand, clarify, or improve treatment of some groups such as Company secretaries, Engineering professionals, Delivery workers and mail carriers, Home improvement installers, Trades assistants, and Tyre, and windscreen fitters
- Discussions around maintaining or discontinuing Major Group 0 Armed Forces Occupations

Discussions around health-related occupations in ISCO-08

Examine the need to expand, clarify, or improve treatment of some health-related occupations, including Specialist Medical Practitioners, Medical technologists, Oral and Maxillofacial surgeons, Paramedical practitioners, Biomedical Engineers, Nursing and Midwifery occupations and Epidemiologists

ISCO skill model (skill levels and skill specialization)

- Discussion about the relevance of basic principles in ISCO-08 including the measurement and use of skill levels as a classification criterion, the adjustment of the boundary between Skill Levels 2 and 3, and the breadth of Skill Level 2
- Discussion about a proposed approach to improve the measurement and use of ISCO skill levels, operational measures, assessment of feasibility and identification of major data sources
- The use of ISCO in the measurement of skill mismatch
- Discussions about occupational groups that are believed to be at the wrong skill level
- Discussions about the potential creation of job families/ clusters (based on skill specializations)

Major Group 6: Skilled agricultural, forestry and fishery workers

- Discussions about the status of the major group
- Discussions about the further splitting of some existing categories
- Discussions around the status of sub major group 63 Subsistence Farmers, Fishers, Hunters and Gatherers

25. Consideration and examination were given to each issue as well as to each recommendation presented in Room Document N.19 of the 20th ICLS (ILO, 2018a), with careful attention paid to assessing their relevance and feasibility. The TWG conducted research and reviewed literature, undertook analysis of available data, reviewed country practices,[11] and consulted with relevant experts to evaluate the recommendations thoroughly and propose alternative ones that were considered more appropriate. Recommendations and decisions made by the TWG were based on consensus.

[11] While the options and recommendations that were made in the 20th ICLS room document N.19 considered a limited number of country cases, the current work examined more than 23 NOCs that were available online and is therefore based on a wider range of experiences such as, but not limited to: Australia, Brazil, Canada, Chile, Italy, India, Indonesia, Kingdom of Saudi Arabia, Kenya, Korea, Lithuania, Malaysia, Mexico, The Netherlands, New Zealand, Pakistan, Palestine, South Africa, Singapore, Switzerland, UK, USA, Viet Nam, etc. in addition to input provided from countries and agencies that are members of the TWG. Additionally, information from international and regional agencies and organizations such as ESCO, CEDEFOP, OECD, O*NET, Pacific Community, UNESCO, ETF, UNECE, UNSD, WHO and many others, including professional associations, journals, specialized sites, etc was gathered and examined. These sources were of particular importance for making recommendations on skill-related issues or specific groups in ISCO and the modernization of ISCO.

26. Some of the major resolved issues are concisely described in the next section, accompanied by the proposed option(s) or solutions along with the main argument(s) supporting the TWG's recommendations to address them. The modernization of ISCO is discussed in Chapter five.

27. It is worth drawing attention to the fact that some issues in the classification are interrelated, and as the TWG continues the work on the ISCO revision, the proposed recommendations might not fully address one or more issues. Furthermore, the TWG might reconsider revising one or more of the proposed recommendations to ensure they are appropriately addressing related concerns. Therefore, it is not recommended at this stage for countries to adopt or implement these proposals in their NOCs. The proposed recommendations are intended as suggestions, and delegates at the conference may wish to carefully evaluate them and share with the office any views they might have. Furthermore, a number of issues remain pending and require additional work; these are not discussed in detail in the room document, but some are briefly listed as part of the planned activities to complete the revision of the classification. (See Chapter Six).

4.1. Proposed improvements to skill-related issues in ISCO-08

Brief description of the ISCO-08 skill model[12]

28. Skill is defined in ISCO-08 as the *ability to carry out the tasks and duties of a given job*. For the purposes of ISCO-08, two dimensions of skill are used to arrange occupations into groups. These are skill level and skill specialization (ILO, 2012) (See § 43-48).[13]

29. Skill level is defined in ISCO-08 as *a function of the complexity and range of tasks and duties to be performed in an occupation*. Skill level is measured operationally by considering one or more of:

    - the nature of the work performed in an occupation in relation to the characteristic tasks and duties defined for each ISCO-08 skill level;
    - the level of formal education defined in terms of the International Standard Classification of Education (ISCED-97) (UNESCO, 1997) required for competent performance of the tasks and duties involved; and
    - the amount of informal on-the-job training and/or previous experience in a related occupation required for competent performance of these tasks and duties.

30. The concept of skill level is applied mainly at the top level of the classification or at the level of major groups, giving more emphasis to the first of these operational measures, the nature of the work performed, than to the formal and informal education and training requirements.

31. Bearing in mind the international character of the classification, only four broad skill levels are defined. Eight of the ten major groups in ISCO-08 contain occupations only at one of the four skill levels, as illustrated in Table 1 below.

[12] A brief description of the ISCO-08 skill model is provided to facilitate the understanding of the nature of the problem and the proposed solution.

[13] Differentiation and grouping of occupations based on skill level was identified as a critical requirement for many statistical and analytical purposes during the development of ISCO-88 and ISCO-08.

▶ Table 1 Application of skill levels to ISCO-08 groups using ISCED-97 categories[14]

<table>
<tr><th>ISCO-08 Skill levels</th><th>ISCED-97 levels</th><th colspan="5">ISCO-08 Major Groups (MG)</th><th>ISCO-08 Major Groups (MG) and Sub Major Groups (SMG)</th></tr>
<tr><td>4</td><td>6 - Second stage of tertiary education)
5a - First stage of tertiary education, 1st degree (medium duration)</td><td colspan="5">MG 2 Professionals (all groups)</td><td>MG 0 Armed Forces Occupations
SMG 01 Commissioned Armed Forces Officers
MG 1 Managers
SMG 11 Chief Executives, Senior Officials and Legislators
SMG 12 Administrative and Commercial Managers.
SMG 13 Production and Specialized Services Managers</td></tr>
<tr><td>3</td><td>5b - First stage of tertiary education (short or medium duration)</td><td colspan="5">MG 3 Technical and Supervisory Workers (all groups)</td><td>MG 1 Managers
SMG 14 Hospitality, Retail and Other Services Managers</td></tr>
<tr><td>2</td><td>4 - Post-secondary, non-tertiary education
3 - Upper secondary level of education
2 - Lower secondary level of education</td><td>MG 4 Clerical Support Workers (all groups)</td><td>MG 5 Services and Sales Workers (all groups)</td><td>MG 6 Skilled Agricultural, Forestry and Fishery Workers (all groups)</td><td>MG 7 Craft and Related Trades Workers (all groups)</td><td>MG 8 Plant and Machine Operators, and Assemblers (all groups)</td><td>MG 0 Armed Forces Occupations
SMG 02 Non-commissioned Armed Forces Officers</td></tr>
<tr><td>1</td><td>1 - Primary level of education</td><td colspan="5">MG 9 Elementary Occupations (all groups)</td><td>MG 0 Armed Forces Occupations
SMG 03 Armed Forces Occupations, Other Rank</td></tr>
</table>

32. Definitions for each of the four skill levels are provided in ISCO-08; they contain examples of the typical or characteristic tasks performed at each skill level (See Box 3 below); the types of skills required (in broad terms); and the typical occupations classified at that skill level. (ILO, 2012) (See section 2.2).

33. The use of ISCED levels to assist in defining the four skill levels in ISCO-08 does not imply that the skills necessary to perform the tasks and duties of a given job can be acquired only through formal education. The skills may be, and often are, acquired through informal training and experience. In addition, it should be emphasized that the focus in ISCO-08 is on the skills required to carry out the tasks and duties of an occupation. It should be noted that the concept of skill level is applied by considering the level of skill required for competent performance of the tasks required for *entry*-level jobs in a particular occupational group. (ILO, 2012) (See §71).

34. ISCO-08 does not classify skills directly. The main tasks and duties performed in each group are listed and this information is then used to determine where in the ISCO hierarchy the group should be placed, with reference both to skill level and the four dimensions of skill specialization.

[14] While this table illustrates the mapping of ISCO-08 groups to ISCED-97 levels of education, it is essential to bear in mind that ISCO-08 skill levels are not solely measured in terms of formal education, as stated earlier. It is also worth noting that all sub major, minor and unit groups are established at the same skill level as the major groups to which they belong. Exceptions to this arrangement are Sub-Major Groups 14, 01, 02, 03 and subsequent groups.

▶ Box 3 ISCO-08 Typical or characteristic tasks performed at each skill level

Skill Level 1 Occupations at Skill Level 1 typically involve the performance of simple and routine physical or manual tasks. They may require the use of hand-held tools, such as shovels, or of simple electrical equipment, such as vacuum cleaners. They involve tasks such as cleaning; digging; lifting and carrying materials by hand; sorting, storing, or assembling goods by hand (sometimes in the context of mechanized operations); operating non-motorized vehicles; and picking fruit and vegetables	**Skill Level 3** Occupations at Skill Level 3 typically involve the performance of complex technical and practical tasks that require an extensive body of factual, technical, and procedural knowledge in a specialized field. Examples of specific tasks performed include ensuring compliance with health, safety, and related regulations; preparing detailed estimates of quantities and costs of materials and labour required for specific projects; coordinating, supervising, controlling and scheduling the activities of other workers; and performing technical functions in support of professionals.
Skill Level 2 Occupations at Skill Level 2 typically involve the performance of tasks such as operating machinery and electronic equipment; driving vehicles; maintenance and repair of electrical and mechanical equipment; and manipulation, ordering and storage of information.	**Skill Level 4** Occupations at Skill Level 4 typically involve the performance of tasks that require complex problem-solving, decision-making and creativity based on an extensive body of theoretical and factual knowledge in a specialized field. The tasks performed typically include analysis and research to extend the body of human knowledge in a particular field, diagnosis and treatment of disease, imparting knowledge to others, and design of structures or machinery and of processes for construction and production.

The information presented here outlines only the typical tasks performed at each skill level. For a comprehensive understanding of the definitions of each skill level, please consult Section 2.2 in ISCO-08

35. Skill specialization in ISCO-08 is considered in terms of four concepts:
    - the field of knowledge required;
    - the tools and machinery used;
    - the materials worked on or with; and
    - the kinds of goods and services produced.

Major skill-related issues in ISCO-08

36. A number of concerns were identified by users of ISCO-08 regarding skill levels, including the following:
    a. The breadth of ISCO-08 Skill Level 2 which has been identified by users as the most problematic of the four ISCO-08 skill levels as it incorporates a broad range of skill complexity;
    b. The boundary between Skill Levels 2 and 3, where the distinction between occupations that require the completion of extensive vocational education and training and those that require a short period of training is not made systematically;
    c. The measurement and use of skill levels as a classification criterion in ISCO-08, where dimensions other than formal levels of education are not identified as a possible requirement in themselves;
    d. Occupational groups that are believed not to be at the most appropriate skill level, mainly resulting from the technological advancement and changes in the world of work since ISCO-08 was launched.
37. These complex issues have significant implications for the use of ISCO. They have affected the proper placement of some occupational groups within the classification framework as well as posed limitations for conducting analysis, including the measurement of skill mismatches, but they have also impacted the use of ISCO in non-statistical operations, etc.

Proposed changes to address major skill-related issues in ISCO-08

38. The TWG is actively engaged in ongoing efforts to identify appropriate approaches to addressing skill-related issues in ISCO-08. The following proposed changes are intended to be considered in their entirety and are proposed as worthy of consideration to address the issues listed in § 36:

    A. Replacing ISCED-97 with ISCED-11;
    B. Reducing the breadth of ISCO-08 Skill Level 2 and adjusting the boundary between Skill Levels 2 and 3;
    C. Improving the measurement and use of skill levels as a classification criterion;
    D. Revising the skill levels of categories that are not a the most appropriate skill level, and
    E. Using standard definitions and improved terminology.

39. Many of the proposed changes are based on the recommendations put forth in Room Document N.19 of the 20th ICLS meeting (ILO, 2018a) (See § 92). Furthermore, additional ones have emerged from discussions within the TWG, a literature review, analysis of available data and information, insights gained from examining country practices and ad-hoc consultations conducted with relevant experts.

40. These proposed changes are outlined in the following sections to facilitate valuable input from conference delegates. However, it is crucial to acknowledge that certain critical details are currently undergoing examination and may influence the finalization of one or more of the proposed changes. Notably, 'C Improving the measurement and use of skill levels as a classification criterion' is currently pending further development and examination to ensure it aligns with all the necessary requirements. Information on the type of potential impact on ISCO or NOC is briefly discussed within each proposed solution, along with the expected work and adjustments to be undertaken for the proper implementation or adaptation of the revised ISCO at the national level. This also illustrates the expected work needed to complete the ISCO-08 revision by the TWG.

4.1.1. Replacing ISCED-97 with ISCED-11

41. **Suggested solution(s):** ISCED-97, which was used in ISCO-08 to assist in defining and measuring levels of formal education, has been replaced by ISCED-11(UNESCO,2011).[15] The TWG recommends replacing ISCED-97 by ISCED-11 in the revised ISCO.

42. **Main arguments**: This change allows the alignment of ISCO with the most recent standard. ISCED is globally recognized and used in a number of NOCs, statistical operations, and other data collections, enabling international comparability. 209 National Educational Frameworks (NEF) are already mapped into ISCED-11,[16] and there exist mapping guidelines between NEF and ISCED (OECD, European Union, UNESCO-UIS, 2015), and mapping between ISCED-97 and ISCED-11 is possible (see Table 2). The use of ISCED-11 to replace ISCED-97 in defining and measuring formal levels of education in ISCO would indirectly contribute to improving the measurement of mismatches, as it aligns with the latest standard that is used in the measurement of qualification and skill mismatches (ILO, 2018d) (see § 4).

43. **Potential impact and required adjustments**. Replacing ISCED-97 by ISCED-11 does not mean a change in the approach used in ISCO-08. It would not necessarily have any known impact on establishing the boundaries between skill levels in ISCO or how occupations are placed within the framework of the classification, despite the minor change in the content of categories of ISCED levels 3 and 4[17] and the detailed categories provided in ISCED-11 Tertiary education (See Table 2). Updated definitions of each of the four skill levels will be provided in the revised ISCO to reflect the recommended changes; these or similar definitions used at the national level would require adjustment of descriptors and all references to ISCED-97 to reflect the use of ISCED-11.

[15] The office is aware that UNESCO has the intention to revise ISCED-11 and will follow-up on this issue and examine any potential implication for ISCO. A mapping between ISCED-11 and its revised version and ISCO skill levels will be provided if this is necessary.

[16] Information about mapping NEF to ISCED can be found here: https://isced.uis.unesco.org/data-mapping/

[17] ISCED-11 Level 4, post-secondary non-tertiary education, corresponds largely to Level 4 in ISCED-97. However, programmes leading to a qualification equivalent to upper secondary general education are classified as Level 3 in ISCED-11, while they were often classified as Level 4 in ISCED-97. (UNESCO 2011, ISCED-11, see page 62).

4.1.2. Reducing the breadth of Skill Level 2 and adjusting the boundary between Skill levels 2 and 3

44. Skill Level 2 in ISCO-08 incorporates a broad range of skill complexity ranging from ISCED level 2 Lower secondary education to ISCED level 4 Post-secondary non-tertiary education, as shown in Table 1, in addition to experience and training requirements (ILO, 2012) (See section 2.2). As a result, the distinction between occupations that require the completion of extensive vocational education and training and those that require a short period of training plus basic literacy and numeracy is not made systematically, as they are classified together in ISCO-08 skill level 2. Problems with the boundary in skill levels between some of the more skilled technical occupations classified at Skill Level 2, included in Major Group 7 Craft and Related Trades Workers, and occupations classified at Skill Level 3, included in Major Group 3 Technicians and Associate Professionals, were reported by users, such as the case of vehicle and aircraft maintenance or electrical, electronics and telecommunications installation and maintenance.

45. This problem becomes more apparent as a number of trades occupations are placed at the same skill level as technical occupations, very often at skill level 3 (or a corresponding level), in a number of recently updated NOCs such as in the case of the UK SOC (UK Office of National Statistics (ONS), 2020) or the Canadian NOC (Statistics Canada, 2021) or the ANZSCO (Australia Bureau of Statistics (ABS), 2021). The breadth of Skill Level 2 in ISCO-08 also resulted in limiting the usefulness of the classification for the analysis of skill level requirements, such as in the case of skill mismatch,[18] or in educational planning, or when ISCO is used in non-statistical operations.

46. **Suggested solution(s):** The TWG recommends adjusting the boundary between Skill Levels 2 and 3 in the revised ISCO as a first solution to reduce the breadth of Skill Level 2 and address the limitations described above without the need to split Skill Level 2 in ISCO.[19] This recommendation consists of moving ISCED-11 Level 4 *Post-secondary non-tertiary education* from ISCO Skill Level 2 to Skill Level 3. Therefore, the following changes will take place:

    - ISCO-08 Skill Level 2, which consisted of ISCED-97 levels 2, 3 and 4, shall consist of ISCED-11 levels 2 and 3 in the revised ISCO.
    - ISCO-08 Skill Level 3, which consisted of ISCED-97 level 5b only, shall consist of ISCED-11 levels 4[20] and 5 in the revised ISCO (See Table 2).

47. An additional solution to assist in reducing the breath of Skill Level 2 in ISCO-08 consists of incorporating additional dimensions as part of the measurement of skill levels, such as specific levels, amounts or periods of training/learning or previous experience after completion of secondary education, which will be established at Skill Level 3 in the revised ISCO. This is further discussed in Section 4.1.3 below.

[18] See for example ILO methodology on mismatch: https://ilostat.ilo.org/258-million-workers-in-the-world-are-over-educated-for-their-jobs/

[19] This is aligned with the recommendation put forth in Room Document N.19 of the 20th ICLS (ILO, 2013a) to maintain four skill levels in ISCO (See § 92 c).

[20] According to ISCED-11, programmes classified at ISCED level 4 may be referred to in many ways, for example: technician diploma, primary professional education, or préparation aux carrières administratives. For international comparability purposes, the term 'post-secondary non-tertiary education' is used to label ISCED level 4. (UNESCO, 2011, See § 188). ISCED-11 level 4 programmes are not considered to be tertiary education and are typically vocational and terminal programmes that prepare for the labour market. (See ISCED-11 § 190).

▶ **Table 2 Correspondence between ISCED-97 /11 and boundary change between ISCO Skill Levels 2 and 3**

ISCO-08 Skill levels	ISCED-97 levels of education	Revised ISCO skill levels	ISCED-11 levels of education	Scope of change on ISCO skill levels
4	**6** - Second stage of tertiary education) **5a** - First stage of tertiary education, 1st degree (medium duration)	**4**	**8 –** Doctoral or equivalent **7 –** Master's or equivalent **6 –** Bachelor's or equivalent	Unchanged[21]
3	**5b** - First stage of tertiary education (short or medium duration)[22]	**3**	**5** – Short-cycle tertiary education **4** - Post-secondary non-tertiary education	ISCED level 4 Post-secondary non-tertiary education is moved from ISCO Skill Level 2 to Skill Level 3.
2	**4** - Post-secondary non-tertiary education **3 -** Upper secondary education **2 -** Lower secondary education	**2**	**3 -** Upper secondary education **2 -** Lower secondary education	
1	**1 -** Primary level of education	**1**	**1 -** Primary level of education **0 –** Early childhood education	Unchanged[23]

48. **Main argument(s)**: This arrangement contributes to reducing the breadth of Skill Level 2 in ISCO by narrowing the range and complexity associated with it. As consequence the distinction between occupations that require the completion of extensive vocational education and training and those that require a short period of training plus basic literacy and numeracy can be made systematically. This will become clearer as we discuss below the proposed improvements to the measurement of skill levels where additional criteria will contribute to the definition of boundaries between skill levels in ISCO. (See 4.1.3). Therefore, a number of occupations currently at Skill Level 2, with higher requirements would move to Skill Level 3, while the rest of the occupations would remain at Skill Level 2. Additionally, by improving the placement of occupations in the framework of ISCO, highly aggregated data would become more homogeneous on skill level. This will contribute to improved analysis based on skill levels, including the measurement of skill mismatches, as reducing the range of skill complexity will contribute to reducing mismatches. The TWG will undertake necessary research and analysis to identify groups necessitating to move to Skill Level 3 as a consequence of the proposed changes.

49. **Potential impact and required adjustments**. In terms of impact on the ISCO structure and the expected work for implementation, as stated earlier, a number of occupations are expected to move to a more appropriate skill level. Some examples are illustrated in Table 4;[24] however, this is not exhaustive as the work is still ongoing (See Section 4.1.4). Similar adjustments would need to take place when implementing ISCO at the national level. Updated definitions of skill levels will be provided in the revised ISCO to reflect the recommended changes, along with examples of typical occupations classified at each skill level. A mapping between the ISCO-08 skill levels and the revised levels will be provided. Principles and guidelines will be provided to assist in classifying an occupation in ISCO in cases where national educational requirements are different from those outlined in ISCO.

50. **Comparison with options and recommendations from the 20th ICLS**: These changes are aligned with the recommendations on the relevance of adjusting the boundary between Skill Levels 2 and 3; and on maintaining four skill levels in ISCO and one skill level per major group (See § 91 and 92 (d) and (g)) and § 32).[25]

[21] ISCED-97 Level 5a is mapped to ISCED-11 Levels 6 and 7. ISCED-97 Level 6 is mapped to ISCED-11 Level 8. This doesn't imply any change on the scope of ISCO Skill Level 4.

[22] ISCED-97 Level 5b is mapped to ISCED-11 Level 5.

[23] The scope of the Skill Level 1 in ISCO will remain unchanged, a note will be added to clarify that ISCO Skill Level 1 is *up to* ISCED-11 Level 1 encompassing ISCED-11 Level 0 and Level 1.

[24] It is important to note that examples related to the potential move of some groups in ISCO that are provided in Table 4 are under consideration within the TWG. They are provided to illustrate the kind of impact on the ISCO structure. However, these examples have not yet undergone thorough discussion within the TWG and the final outcome remains subject to change.

[25] Exceptionally skill levels would be set at the level of Sub Major Groups 14, 01, 02, 03 as in ISCO-08. As discussions regarding the treatment of categories in sub major group 14 are still ongoing, this outcome is subject to change. However, as Major Group 0 Armed Forces Occupations will be maintained in the revised ISCO, the current treatment regarding skill levels of categories within this group will not change.

4.1.3. Improving the measurement and use of skill levels as a classification criterion

51. Although the operational measurement of skill levels in ISCO-08 considered several criteria, such as experience and informal on-the-job training, in addition to formal education (See § 29 above), not all dimensions were identified as independent requirements. For example, experience was not recognized as a distinct requirement that could potentially justify a higher skill level. This resulted in inadequate recognition of skills obtained through experience and has had implications for the placement of occupations fed through internal job ladders or internal job progression, such as in the case of supervisors who may require years of experience in the jobs of those they supervise. Additionally, managerial responsibilities were not considered in the definitions of skill levels of ISCO-08[26] and consequently, the recognition of additional administrative and managerial responsibilities for small business operators was not possible. Furthermore, the distinction between many occupations established at Skill Level 2 was not made systematically because of the wide range of skill complexity, mainly measured in terms of formal education, associated with this level in ISCO-08, as explained in Section 4.1.2 above.

52. **Suggested solution(s):** The TWG is actively engaged in ongoing discussions to complete the work related to a proposed approach for improving the measurement and use of skill levels as a classification criterion in the revised ISCO. Major components and elements of the approach have been identified as elaborated on in the following paragraphs. Nevertheless, certain details necessitate further refinement or work, as indicated where appropriate. The approach that has gained general agreement, in principle, within the TWG involves extending the measurement of skill levels in the revised ISCO, where the boundaries between skill levels would be based on sets of criteria or dimension in addition to the level of formal education.

53. As mentioned earlier, a number of criteria were used in the operational measurement of the ISCO-08 skill levels without, however, contributing to the delineation of skill level boundaries as they were not treated as independent criteria. To address this limitation, the revised ISCO aims to explicitly incorporate these and other requirements as part of the operational measurement of skill levels, which are used as a classification criterion. In the proposed framework, the measurement of skill levels will be operationalized by considering one or more of the following criteria: the nature of work performed in an occupation, the level of formal education required, the responsibilities required, the amount of previous experience, and '*other forms of training*', which the TWG is currently identifying.[27] An adaptation of the ISCO-08 skill level definition (See § 29 above) illustrates the proposed improvements, which are underlined in the paragraph below:

> *Skill level is defined as a function of the complexity and range of tasks and duties to be performed in an occupation. Skill level is measured operationally by considering one or more of:*
>
> - *The nature of the work performed in an occupation in relation to the characteristic tasks and duties defined for each of the revised ISCO skill level; (unchanged with ISCO-08)*
> - *The level of formal education defined in terms of the International Standard Classification of Education (ISCED-11) required for competent performance of these tasks and duties involved; (unchanged with ISCO-08, but ISCED-11 replaces ISCED-97)*
> - *The extent of responsibilities required for competent performance of these tasks and duties involved; (explicitly incorporated within the operational measurement)*
> - *The amount of previous experience required for competent performance of these tasks and duties involved, (objectively defined using a duration) and*
> - *The amount of 'other forms of training/learning' required for competent performance of these tasks and duties involved. (Which the TWG is currently identifying).*

[26] For example, management responsibility for self-employed/owner-operators of businesses was briefly mentioned in the description of Major Group 7. A note is sometimes provided, where relevant, to assist in coding operators of small business.

[27] The TWG is currently engaged in an ongoing discussion related to the identification of these forms of training/ learning and establishing their corresponding measures. One or more forms of work-based training/learning might be used as a criterion, taking into consideration recent developments, including ILO work on this topic. The concept of work-based training/ learning is becoming a topic of high policy interest in many countries for evident reasons, including developing the needed skills to enter and progress in many jobs. For more information, please visit https://www.ilo.org/skills/areas/work-based-learning/lang--en/index.htm and read the 21st ICLS Room Document N.25.

54. The skill level framework in Table 3 illustrates how this approach could work by demonstrating how each criterion can be measured and contribute to defining the boundaries between skill levels in the revised ISCO.

55. As can be noted, this approach builds on the ISCO-08 conceptual approach but offers a more comprehensive consideration of the concept of skill, where a set of criteria will be used for determining the skill level for occupations in the ISCO (the inclusion criteria for each skill level). The approach also expands on the recommendation that the breadth of Skill Level 2 in ISCO-08 should be narrowed by adjusting the boundary between Skill Levels 2 and 3, taking into consideration training and/or experience undertaken after completion of secondary education. [28]

56. Additional dimensions might be used in the description of each skill level; they will not, however, contribute to establishing the boundaries between skill levels and will not be used systematically as part of the assessment of the skill levels of a particular occupational group. For example, literacy and numeracy,[29] interpersonal communication skills, physical dexterity, and maybe others will be broadly described in each of the four skill levels, like in ISCO-08.[30] They will assist in better establishing the scope of each skill level, including the typical or characteristic tasks performed at each skill level.

How were the measures established?

57. While ISCED-11 will be used in defining and measuring formal education in the revised ISCO (See 4.1.1), there are no (global) frameworks that can be used to establish a measure for most of the remaining criteria. Since skills are broadly defined in the ISCO and should be considered indicative, a plausible approach, which has gained general agreement in the TWG, consists of using a qualitative description of criteria accompanied by an operational measure in the form of '*typical requirement*'[31] in terms of the amount, or complexity, or length of the learning, responsibility, experience, and training involved at each of the four skill levels, when this is relevant. They provide an indication about the *typical* or *common* requirements to enter and competently perform the tasks and duties for an occupation at a specific skill level. The concept of skill level is applied by considering the level of skill required for competent performance of the work for entry-level jobs in a particular occupational group (like in ISCO-08, see ISCO-08 § 71).

58. The operational measures for each criterion consider and progressively illustrate the corresponding levels of complexity and range of tasks and duties to be performed in an occupation at each skill level. For instance, the suggested operational measure for experience[32] uses durations that are established for each of the four skill levels in the revised ISCO. These range from '*few days to a few months of experience'* for most occupations at skill level 1; and '*five or more years of experience in a related occupation from skill level 3 or 4, often in a specialized field*', for occupations at skill level 4, when this is applicable, and so on.

59. In general, the TWG considered the operational measures along with the typical requirements plausible and agreeable. They were established after examining and analysing a wide range of (proxy) available information as explained in this document.

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[28] This recommendation was made in Room Document N.19 of the 20th ICLS (See § 92) and see Section 4.1.2 above. This shall be concretely demonstrated once the criteria and the operational measures for '*other forms of training/ learning'* are established.

[29] Literacy and Numeracy are enabling factors for the performance of many occupational tasks; they are closely related to the levels of formal education as they are very often studied in educational programs and can be predicted by the corresponding levels. The TWG is exploring the feasibility of considering Literacy and Numeracy among the criteria to measure skill levels.

[30] Most of these dimensions were also used in the description of the four skill levels in ISCO-08. For more information see (ILO, 2012) (See 2.2).

[31] Typical requirements refer in this context to the *most common* requirements necessary to obtain the relevant skills to enter and competently perform the role in a job as observed in similar circumstances or in NOCs using skill levels in the classification's design or as commonly required by employers. For example, *minimum requirements* established in this framework were comparable to the minimum requirements established in many sources, including NOCs such as the UK SOC, the ANZSCO, the Canadian NOC (uses TEER instead of skill levels), the US O*NET, the US BLS, South Africa and others. The Netherlands also compared the proposed measures to nationally available information on experience requirements. Additionally, analysis of available data from (LFS) surveys was also undertaken by Brazil, Mexico, Switzerland, and Viet Nam on available information regarding years of experience and work-based training/learning by ISCO major groups and skill levels. This information was then used to assist in identifying occupational groups requiring training and/or experience. The TWG might undertake further analysis if more data becomes available in a reasonable time to assist in refining these measures if necessary.

[32] For example, the typical duration for Experience was established after examining country practices and analysing available data and comparing the proposed duration with NOCs. Additionally, an analysis of information pertaining to years of experience was undertaken on 6.2 million online job advertisements from South Africa for the years 2016 to 2019. This analysis was undertaken in collaboration with the ILO Research Department.

▶ **Table 3 Proposed skill levels framework for the revised ISCO**

Dimension	Inclusion criteria for Skill level 1	Inclusion criteria for Skill level 2	Inclusion criteria for Skill level 3	Inclusion criteria for Skill level 4
Formal levels of education	Up to primary education	Lower secondary education or Upper secondary education[33]	Post-secondary non-tertiary education or Short-cycle tertiary education	Bachelor's or Master's or Doctoral or equivalent level
Typical requirements using ISCED-11 levels	*Up to ISCED-11 level 1*	*ISCED-11 level 2 or level 3*	*ISCED-11 level 4 or level 5*	*ISCED-11 level 6 or level 7 or level 8*
Responsibilities[34]	No responsibilities are involved (none)	Not a significant component of the work	Moderate component of the work	Significant component of the work[35]
Typical requirements	*Not a requirement, most jobs are supervised by workers at other Skill levels. Occupations at this skill level require close and extensive guidance. They typically involve performing simple and routine tasks with minimal decision-making.*	*Relevant for some occupations when this involves carrying out the line or technical work with limited supervision of workers and/or overseeing of the day-to-day activities of a small business, but responsibilities are not a major component of the work. Occupations at this skill level typically involve a range of tasks that may require some degree of judgement.*	*Relevant for some occupations[36] when this involves: -Supervision of staff when supervisors do not mainly perform the same tasks as the workers they supervise, or - Considerable safety responsibility Occupations at this level typically involve a variety of tasks that require independent decision-making.*	*Relevant for some occupations -when management of an enterprise or organization or a department within an organization with a hierarchy of managers is the major or significant component of the work. - or when occupations typically involve complex tasks that require advanced skills, knowledge, and significant decision-making.*
Experience	Little or no previous experience is required	Some previous relevant experience is required	Considerable previous relevant experience is required	Extensive previous relevant experience is required
Typical requirements	*Few days to a few months, when applicable*	*Less than 2 years in a related occupation, when applicable*	*Between 2 and less than 5 years in a related occupation from skill level 2, possibly in a related field, when applicable.*	*5 or more years in a related occupation from skill levels 3 or 4, often in a specialized field, when applicable*
Other training/learning dimensions (To be identified)	Ongoing discussion within the TWG *(example:[37]often not a requirement, but a short demonstration or a basic level training/ learning may be provided for some jobs classified at this level)*	*Ongoing discussion within the TWG (example: a moderate-term or initial levels of training/learning may be provided for some jobs classified at this level, in some cases leading to a certification[38], if any)*	*Ongoing discussion within the TWG (example: may involve long-term or advanced levels of specialized training/ learning provided after completion of secondary education, in some cases leading to a diploma, if any)*	*Ongoing discussion within the TWG (example: often not a requirement, but may involve some highly specialized or professional training/learning to develop expertise, when relevant)*

[33] Specialized vocational education is included in formal education starting at ISCED level 2, when relevant.

[34] Managerial responsibilities were established on the basis of the ISCO-08 description of managerial roles in addition to the review of available literature from various sources including ISO management system standards (ISO, n.d.); Tasks within Occupations (European Centre for the Development of Vocational Training (CEDEFOP), n.d.); The BLS Management occupations (BLS, 2022a); WHO Global Competency and Outcome Framework for UHC (WHO, 2022); Education Standards for Prosthetic/Orthotic Occupations (ISPO, 2022); The Corporate Secretary: The Governance Professional Handbook (The International Finance Corporation, 2016) and information from Canada NOC and the O*NET and other sources.

[35] For the purposes of ISCO, a significant component of the work should involve spending most of the time in a management role, or mainly performing supervisory/management tasks; or when this is a frequent element of the work; or when the supervision/ management is a predominant task of the work as reported by respondents to survey questionnaires or in administrative forms. A typology of these forms of responsibilities will be provided to assist in placing categories in the framework of ISCO and to assist in distinguishing between the related roles.

[36] The TWG is currently engaged in an ongoing discussion related to the treatment of operators of small businesses for whom management is a major component of the work. This discussion may lead to a potential change in establishing the boundary between skill levels 2 and 3 regarding how managerial responsibilities are operationally measured. Revising skill levels for a number of occupations in ISCO might also influence this measure.

[37] It is important to note that these examples are not final and may change as discussions related to the criteria and their corresponding measures are still ongoing within the TWG, they are provided here to illustrate how these criteria could be measured.

[38] This would not mean that only formal forms of work-based training/ learning will be taken into account in defining this criterion.

How could this approach work?

60. The necessary principles and guidelines have been drafted to facilitate a consistent and systematic implementation of this approach across countries and to maintain the international comparability of statistics on occupations. They aim at ensuring that the same occupation will not be treated differently, or placed at a different skill level, even in cases where there *may* be (slight) differences in terms of the *typical requirements* among countries, jobholders, or other settings; or in cases where multiple dimensions can be considered in placing an occupation at a particular skill level. The following should be taken into account when making decisions about where in the revised ISCO to classify occupations with respect to skill levels:

    a) if any one of the criteria for inclusion at a specific skill level is a requirement for entry to an occupation or is the usual method of entry, then the occupation would be classified at that level;
    b) typically, as the complexity and range of tasks and duties increase with skill levels, so do the levels of formal education, previous experience, '*other forms of training/learning*', and sometimes the responsibilities required to enter and competently perform the work associated with a particular occupation;
    c) skill levels are mainly applied at the major group level; and when measuring skill levels more emphasis is given to the nature of the work performed in an occupation in relation to specific tasks and duties at a particular skill level[39] than to the rest of the dimensions, particularly if formal education is not the usual method of entry or a relevant requirement for competent performance in a particular occupation, or in cases where national skill level requirements, measured in terms of formal education, are different;
    d) any occupation for which there is a formal requirement for qualifications at a particular skill level should be classified at the corresponding level. However, as stated in point 'c', if national requirements, measured in terms of formal education, are different from those used in ISCO, then job content (specific tasks and duties) is given priority over national education requirements;
    e) responsibilities will determine the placement of a category based on whether these requirements are considered a significant component of the work within an occupation;
    f) the consideration of experience or '*other forms of training/learning*' will be used as classification criteria if none of the other criteria (formal education, responsibilities) are applicable. [40] They are relevant aspects of the operational measurement of the skill level of an occupation when formal education is not the only, the suitable, or the usual entry or method to gaining the skills required to competently perform the task in a specific occupation or to measuring its skill level, or when no responsibilities are involved in performing the job;
    g) a slight variation (shorter or longer, lower or higher) in the typical requirements should not lead to a different treatment of an occupation with respect to skill levels as the emphasis should always be given to the job content (characteristics tasks and duties) at a particular skill level in ISCO, as occupations that involve the performance of broadly the same sets of tasks and duties shall always be classified in the same category of the revised ISCO or its national adaptation. That is possible because the tasks performed and skills required for competent performance in a particular occupation are generally the same in different countries, regardless of national differences in educational and training requirements for entry into that occupation;
    h) if, due to specific national needs, an occupation is set at a different skill level at the national level than in the revised ISCO, it should primarily be mapped to the corresponding group (s) in ISCO when national data are reported according to ISCO. The mapping should be done on the basis of the nature of the work performed in an occupation or its characteristic tasks and duties.

61. The following cases illustrate how this approach might work in practice. Taking medical practitioners as an example, most of the jobs in this category would not typically require previous experience to enter and competently perform the work, and this would not mean that these jobs would not be placed at Skill Level 4 in ISCO, because in this case, formal education at ISCED level 6 and above, or its equivalent, is considered a *typical*

[39] See Box 3 as an example of typical tasks in ISCO-08. These typical tasks will be updated in the revised ISCO to reflect the proposed changes.
[40] It is important to note that the principles and guidelines do not attempt to assign importance to any specific criterion over the others.

requirement[41] *for most* of these jobs, and they are consequently placed at the corresponding skill level in ISCO. In other words, since the level of formal education at bachelor's degree or higher is established as an inclusion criterion at Skill Level 4, any occupation requiring this or an equivalent level of formal education should be classified at Skill Level 4, when formal education is considered a typical requirement for the performance of tasks and duties in that occupation. Taking another example, a long period of work-based training will be considered in the placement of some trade's occupations at Skill Level 3 in ISCO, such as vehicle technicians and repairers. The typical entry for these jobs at this level is not formal education, but rather a long-term of on-the-job training or advanced levels of apprenticeships can be provided or required by the employer.

Sources of information for adaptation and implementation

62. Various sources of information can be used to obtain the necessary information for the adaptation of the proposed skill level framework at the national level. These include information from statistical and non-statistical operations, including the regular collection of information using the ILO model questionnaire on Occupational qualifications and skills mismatches (ILO, 2020a).[42] Specialized surveys or modules exist at the national level in various countries,[43] they can be used for this purpose as well. In general, this would not involve implementing a dedicated survey to obtain needed data as (proxy) information can be used from various sources, such as from job advertisements or vacancies (ILO, 2020b), information from employers, industries, training, and teaching curricula, and information from national skills authorities/ commissions, information from job matching services or public and private employment services, and information from professional and industrial associations, etc. These sources are useful for national adaptation or implementation of the framework, as they can provide necessary information on the various types of requirements.

63. Almost all the criteria used in this framework are also used in NEF/ NQF or equivalent vocational education frameworks, and these could be easily mapped to the skill levels and/or to the characteristics tasks at each skill level in in the revised ISCO, as NQFs establish important links between the world of work and education.[44] This will greatly assist countries in the implementation of the proposed changes. Many of the visited NOCs have followed a similar process of using various sources of information in the updating or revision of their classification, and NQF exists almost globally in more than 150 countries; in some cases, regional qualification frameworks are available, such as in the case of Europe, or ASEAN, or the Caribbean region.[45]

64. The use of the various data sources builds on the importance and relevance of involving and collaborating with key national partners (National statistics office, relevant ministries or national agencies, employers and workers organizations, etc.) in the development and revision or adaptation of the NOC.

Potential impact and required adjustments

65. The proposed approach is expected to have an impact on the ISCO structure. For instance, by considering supervisory responsibilities and experience in defining the boundaries between skill levels, we could reassign supervisors to Major Group 3 especially when these responsibilities form a significant part of the work.[46] Some categories involving considerable safety responsibilities, such as police officers and firefighters, could also be moved to Skill Level 3, where requirements such as longer (on-the-job or supervised practical) training will be better reflected. Furthermore, some categories shall be moved from Skill Level 2 to Skill Level 3 based on the '*other forms of training/learning'* requirements (such as apprenticeship or any other work-based training), which the TWG is currently working on establishing. This is, for example, the case of aircraft engine mechanics and repairers and electrical mechanics and repairers. (See Table 4). Additionally, the code numbers of certain categories, as well as group descriptions and scope, will change. This approach will also have an impact on NOCs, and countries are expected to make the necessary adjustments to instruments, material,[47] group codes and labels used, including in related databases.

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[41] As observed in NOCs, such as in the case of Canada NOC, UK SOC and others.
[42] This document is available at: https://ilostat.ilo.org/resources/lfs-resources/
[43] For example, the US Occupational Requirements Survey (ORS), for more information, see (BLS, 2022) (O*NET , n.d)
[44] Also see An Introductory guide to National Qualifications Framework: Conceptual and Practical issues for policy makers (ILO, 2007).
[45] Read more about the Global Inventory of Regional and National Qualifications Framework here: https://uil.unesco.org/fileadmin/keydocuments/LifelongLearning/en/NQFInventoryVol1.pdf
[46] This will become more relevant if we consider the recommendation that was put forth in Room Document N.19 of the 20th ICLS (ILO, 2018a) on giving primacy to skill level over skill specialization (See § 92 (c)).
[47] This includes the index of occupational titles and the crosswalk between the two versions of ISCO or NOC.

▶ Table 4 Proposed revised ISCO major groups[48]

ISCO-08 Major Groups	Revised ISCO Major Groups	Scope of groups, examples of occupations included and potential change.	Skill Level
1 Managers	1 Managers	Scope: includes most of the occupations of ISCO-08 Major Group 1, such as Managers in an organization with a hierarchy of managers or in a specialized role. Potential change: There is an ongoing discussion regarding the treatment of operators of small businesses including Sub Major Group 14 Hospitality, Retail and Other Services Managers which might result in a change in the current treatment.	3,4
2 Professionals	2 Professionals	Scope: includes most of the occupations of ISCO-08 Major Group 2, such as engineers, medical doctors and nurses, teaching professionals, business and administration professionals, ICT professionals, and legal, social and cultural professionals. Potential change: some occupations that now require a bachelors' degree could be moved from Major Group 3 to Major Group 2, such as radiographers, medical laboratory technologists, prosthetists, orthotist and maybe others.	4
3 Technicians and Associate Professionals	3 Technical and Supervisory Workers (Group name might change to explicitly reflect the inclusion of supervisory occupations)	Scope: includes most occupations of ISCO-08 Major Group 3, such as science and engineering technicians, health associate professionals, business and administration associate professionals, legal, social and cultural associate professionals and ICT technicians. Potential change: some occupations requiring post-secondary non-tertiary education, or longer periods of training or experience, or supervision of other worker or requiring considerable safety responsibilities, could be moved to this group, example: • Some highly skilled occupations from Major Group 4 such as bank tellers and related clerks • Some supervisory and other occupations from Major Group 5 such shop supervisors, police officers, firefighters, etc. • Some trades occupations from Major Group 7 such as aircraft engine mechanics and repairers, electrical mechanics and repairers. • Some occupations moved from Major Group 8 such as miners and quarriers, well drillers and borers, etc Depending on the final size and scope of this group, it might be divided into two major groups, each set at skill level 3. This will also depend on the discussions related to assessing the skill levels of some groups in Major Group 6 as well as the treatment of small business operators.	3
4 Clerical Support Workers	4 Clerical Support Workers	Scope: includes most occupations of ISCO-08 Major Group 4 such as general office clerks, customer service clerks, contact centre information clerks, receptionists, personnel clerks Potential change: a small number of occupations could be moved to Major Group 3 (see above).	2
5 Service and Sales Workers	5 Services and Sales Workers	Scope: includes most occupations of ISCO-08 Major Group 5, such as shop sales assistants, waiters, cooks, hairdressers, personal care workers, security guards. Potential change: a small number of occupations could be moved to Major Group 3 (see above). Few occupations might move to Major Group 9 (see below).	2
6 Skilled Agriculture, Forestry and Fisheries Workers	6 Skilled Agriculture, Forestry and Fisheries Workers	Scope: includes most occupations of ISCO-08 Major Group 6, such as Skilled Agriculture, Forestry and Fisheries Workers. Potential change: Sub Major Group 63 discontinued all subsequent unit groups merged with sub major groups 61 and/or 62. Additionally, there is an ongoing discussion related to revising the skill levels of categories in this group, which might lead to additional changes.	2
7 Craft and Related Trades Workers	7 Craft and related trades workers	Scope: includes most occupations of ISCO-08 Major Group 7, that do not involve supervision or higher skill levels such as welders, tailors, carpenters, butchers Potential change: a small number of occupations could be moved to Major Group 3 (see above). Few occupations might move to Major Group 9 (see below).	2
8 Plant and Machine Operators, and Assemblers	8 Plant and Machine Operators, and Assemblers	Scope: includes most occupations of ISCO-08 Major Group 8, such as sewing machine operators, vehicle drivers, mobile plant operators. Potential change: a small number of occupations could be moved to Major Group 3 (see above). Few occupations might move to Major Group 9 (see below)	2
9 Elementary Occupations	9 Elementary Occupations	Scope: includes most occupations of ISCO-08 Major Group 9, such as cleaners, labourers, fast food preparers, street vendors. Potential change: a small number of occupations could be moved from major groups: 5 (domestic housekeepers[49]), 7 (such as assisting occupations e.g., electrician's assistant) and 8 (wrapping, packing and labelling machine tenders, car park attendants and parking valets,) etc	1
0 Armed Forces Occupations	0 Armed Forces Occupations	Scope: includes most occupations of ISCO-08 Major Group 0. Maintained without changes after careful examination and discussions undertaken by the TWG.	1,2,4

[48] This table reflects the impact of the proposed skill levels framework and the boundary change between Skill Levels 2 and 3.
[49] The scope of this category would need to change to exclude bed and breakfast operators and guest house operators for evident reasons.

66. Table 4 summarizes the potential changes in ISCO that are arising from the impact of introducing the skill level framework as well as the impact of the change in the boundary between Skill Levels 2 and 3.[50] However, it does not fully capture the impact resulting from the change in skill levels of existing occupations nor the outcome of discussions related to the treatment of operators of small businesses, including Sub Major Group 14 Hospitality, Retail and Other Services Managers, or Major Group 6 Skilled Agriculture, Forestry and Fisheries Workers, which will likely result in moving categories around the classification; nor does it accommodate new and emerging occupations, as these are yet to be identified by the TWG. (see Section 4.14 below).

67. The needed guidance will be provided to facilitate the implementation of the skill level framework. For example, a methodological note will highlight the major changes related to the skill levels. The definition of each of the four skill levels will be updated to reflect all the proposed changes and provide clarity regarding the characteristic tasks and duties. The types of skills required, along with a list of typical occupations classified at each skill level, will be provided as well. This information will be accompanied by the guidelines and principles listed above to ensure a systematic implementation of the framework and contribute to the production of internationally comparable statistics on occupations. A crosswalk explaining the types of changes and the relationship between the categories will be provided.

68. Additional work is expected to address the following considerations: i) determining the criteria to be retained, including defining and measuring '*other forms of training/ learning*'; ii) improving the established operational measures in the form of 'typical requirements', where necessary; and iii) finalizing the assessment to identify all categories that would require to be moved within the structure of ISCO. Feedback from the delegates at the ICLS on the relevance of the proposed approach in addressing the known issues and limitations in ISCO-08 is necessary to guide the TWG in completing the work to address these skill-related issues.

69. **Main argument(s)**: The TWG recognizes the appropriateness of the proposed approach to address the known limitations of ISCO-08 and does not consider the inclusion of one or more criteria as part of the measurement of skill levels in ISCO to depart from the approach used in ISCO-08, which is essential to maintain for evident reasons. The proposed approach better reflects the requirements and contributes to improving their placement within the framework of the classification without fundamentally impacting major groups, as illustrated in Table 4. Furthermore, this approach contributes to addressing problems of suitability of ISCO for the analysis of skill qualifications and mismatches by narrowing the breadth of Skill Level 2 without moving the boundaries between Skill Levels 1 and 4[51]. The proposed changes will equally improve the use of ISCO in non-statistical operations, such as education planning and matching job seekers with vacancies, etc.

70. **Country practices**: It is worth noting that a number of recently updated NOCs or similar classifications, using skill level in the design of the NOC, include multiple dimensions in the skill level's measurement where criteria other than formal education are taken into consideration in assessing the range and complexity of tasks performed in a particular occupation. For example, one or more of the following requirements, such as experience, responsibilities and forms of work-based learning/ training, in addition to formal education are being used in the Canadian NOC 2021[52] (Statistics Canada, 2021), the ANZSCO 2021 (Australia Bureau of Statistics (ABS), 2021), the O*NET (US department of labour, n.d), Mexico SINCO (Instituto Nacional De Estadística Y Geografía, Mexico, 2019), the UK SOC (UK Office of National Statistics (ONS), 2020), South Africa (Public Service and Administration, Republic of South Africa, 2021), Indonesia's Occupational Tasks and Skills 2021 (World Bank, 2020), the Netherlands (ROA-CBS 2014) (Central bureau voor de statistiek, the Netherlands, 2014), and maybe others. For example, firefighters and police officers are at skill level 3 or its equivalent in NOCs and this is mainly justified by an extend safety responsibility and a longer period of supervised practical training or on-the-job training but not necessarily the completion of formal education, such as in the case of the UK or the ANZSCO. Some operators of small businesses[53] are included in skill level 4 or a managerial level, and this is justified by the fact that several years of work experience is a typical requirement for their inclusion

[50] It is important to note that examples related to the potential move of some groups in ISCO that are provided in Table 4 are under consideration within the TWG. They are provided to illustrate the kind of impact on the ISCO structure. However, it's important to highlight that these examples have not yet undergone thorough discussion within the TWG and that the final outcome remains subject to change.

[51] The consequences of moving the boundary between Skill Level 1 and 2 would be that occupations that do require basic numeracy and literacy (e.g., basic sales and clerical occupations) would be classified at Skill Level 1. (See ILO, 2018a § 87). In addition, this would have no impact on occupations established at Skill Levels 1 and 4, and the proposed boundaries are now comparable to boundaries established in various NOCs.

[52] In the case of the Canada NOC this is referred to as TEER levels: Training, Education, Experience and Responsibilities.

[53] They are sometimes referred to as proprietors in NOCs.

at this level, such as in the case of operators in agriculture or hospitality services. Electronics and mechanics and servicers or aircraft engine mechanics and repairers are placed at a higher skill level than that in ISCO, and this is mainly because apprenticeship is a typical requirement.

71. **Comparison with options and recommendations from the 20th ICLS**: The proposed approach builds and capitalizes on the ISCO-08 skill levels and takes into account the recommendations made in Room Document N.19 of the 20th ICLS meeting (ILO, 2018a). (See § 92 recommendations (i), (j), (k) and (l)). Measures and typical requirements were discussed and agreed within the TWG; they were established on the basis of review of literature and analysis of available information and data, in addition to experts' knowledge, as explained elsewhere in this document.

4.1.4. Revising the skill levels of categories that are not at the most appropriate skill level

72. A number of groups are not considered to be placed at the most suitable skill levels, such as in the case of some medical technicians' occupations requiring a higher educational requirement, for example. Or like in the case of other categories for which the current skill level was considered high, such as domestic housekeepers, wrapping, packing and labelling machine tenders, car park attendants and parking valets, etc. all of which are at ISCO Skill Level 2, while they are established at a lower skill level in NOCs.

73. A list of categories that were not considered at the most appropriate skill level was presented in the Room Document N.19 of the 20th ICLS (ILO, 2018a) (see § 80-82). Furthermore, the TWG is currently evaluating additional unit groups that may require a change in their skill levels (example: skilled agriculture workers, police officers, operators of small businesses, supervisors, etc.). This becomes evident considering the proposed modifications to the boundary between Skill Levels 2 and 3 and the proposed measurement of skill levels in the revised ISCO (See Sections 4.1.2 and 4.1.3 above). Several sources are being used in this exercise, including input from the TWG, the comparison of ISCO-08 with recently updated NOCs that use skill level and a literature review of available (proxy) information from a wide range of relevant sources. However, as this work is still in progress, the outcomes of this assessment are not further elaborated upon in this document and only a few examples of concerned groups were illustrated in Table 4 above. [54]

74. The revision of the skill levels of categories will certainly have an impact on the ISCO structure as some groups are expected, for example, to move around the classification. While the TWG ensures to minimize the breaks in series resulting from such revision, it is also keen on keeping ISCO relevant and mirroring the reality of the labour market. In terms of expected work to be undertaken to complete this task, some adjustments would need to be undertaken in ISCO and NOCs, these involve adjustments to instruments, material[55] and group codes used, including in related databases.

4.1.5. Using standard definitions and improved terminology

75. Standard definitions of dimensions used as part of the measurement of skill level will be provided when necessary. This aims at promoting the comparability of similar concepts. A typology of the various types of responsibilities will be provided to clarify the scope of responsibilities and decision-making at each skill level, along with reporting lines and accountability, when applicable. It will serve to facilitate the distinction between the various managerial roles and clarify the boundaries with supervisory roles. This will contribute to a clear understanding of the group's scope and assist countries in the implementation and adaptation of ISCO. Additionally, the TWG has put forth a proposal to utilize enhanced and suitable terminology in the measures of the various concepts and dimensions used in the skill levels framework of the revised ISCO, as demonstrated in Table 3.[56] This proposed terminology draws inspiration from related and relevant frameworks and NOCs. It

[54] It is important to note that these examples have not yet undergone thorough discussion within the TWG, and that the outcome remains subject to change.

[55] This includes the index of occupational titles and the crosswalk between the two versions of ISCO or NOC.

[56] An improved terminology is also utilised for literacy and numeracy, which are not illustrated in this table but will be used as part of the definitions of each of the four skill levels.

contributes to a clearer understanding of the measures and the use of the skill levels framework, which is believed to further promote international comparability of statistics on occupations.

4.1.6. Contributing to improving the measurement of skill mismatch

76. The 18th ICLS (ILO, 2008) discussed the use of skill mismatch as a potential indicator or component of the measurement of labour underutilization. The 20th ICLS adopted the guidelines concerning the measurement of qualifications and skills mismatches of persons in employment (ILO, 2018d)[57] aiming to set standards for defining and measuring qualification and skills mismatches of persons in employment and facilitate the production of statistics on mismatches that can complement the existing measures of labour underutilization, in particular unemployment, time-related underemployment and potential labour force.

77. The measurement of mismatch by level of education requires information about the highest level of educational attainment of a person in employment, their occupation, and the information regarding the relevance of different levels of education for each occupation or occupational group. Measurement of skill mismatch requires information about the skills required for competent performance on the job and the skills possessed by a person in employment (See § 11 and 18 of the guidelines).

78. The 20th ICLS (ILO, 2018a) specifies that 'any work to review or update ISCO-08 would therefore need to take into consideration the suitability of the classification for the measurement of skill underutilization' (See § 23).

79. **Proposed solution(s):** The TWG considers the following changes as appropriate measures to contribute to the improvement of the measurement mismatches:

    a) Reducing the breadth of ISCO-08 Skill Level 2, and adjusting the boundary between Skill Levels 2 and 3 in ISCO, and the identifying groups requiring moving to skill level 3 for an improved assessment of the required skill levels;[58]
    b) Introducing a skill levels framework with an alternative set of criteria to assist in the measurement of skill levels, which would contribute to a better placement of some categories in the framework of ISCO with respect to skill levels;
    c) Revising the skill level for a number of occupations that might not be at the most appropriate skill level. As a consequence of 'a', 'b' and 'c' above highly aggregated data would become more homogeneous on skill level, contributing to improved analysis based on skill levels, including the measurement of skill mismatches;
    d) Replacing ISCED-97 by ISCED-11 in measuring formal levels of education in ISCO, as it aligns with the latest standard that is used in the measurement of qualification and skill mismatches; and
    e) Encouraging countries to disseminate and/or share their statistics on occupation at ISCO 2-digit levels at the minimum when this is feasible, as so far most of the analysis, including mismatches, is conducted at the ISCO major groups level, which is very broad and not very informative for such purposes.

80. **Main arguments:** ISCO is a classification of occupations where skills are defined in a broad manner and used as a classification criterion. The entity classified in ISCO is the job and not the person who holds the job, where the skills or qualifications held by the person are not considered in the classification/coding of the job in ISCO (See ISCO-08 § 70). The skill level of an occupation in ISCO should be assessed on the basis of the skill required for competent performance in the occupation and not necessarily on the basis of the skills or qualifications actually held by individuals employed in the occupation. Therefore, the proposed changes were considered satisfactory by the TWG and a step forward to address policymakers needs as they contribute to improving the measurement of skill mismatches. No specific impact is expected on ISCO or NOC.

81. **Comparison with options and recommendations from the 20th ICLS**: No concrete proposal was made during the 20th ICLS.

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[57] The document is available at: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/meetingdocument/wcms_648557.pdf

[58] Methodological notes and detailed estimates of mismatches are available at: https://ilostat.ilo.org/258-million-workers-in-the-world-are-over-educated-for-their-jobs/#:~:text=More%20than%20935%20million%20workers,million)%20are%20over%2Deducated.

4.2. Aligning ISCO with recent statistical standards

82. Aligning ISCO with recent and relevant labour standards is essential as this provides consistency among these statistical standards and promotes relevant policy formulation. It was therefore essential for the TWG to assess modalities to align ISCO with ISCED-11 and the 19th and 20th ICLS resolution I. Discussion about replacing ISCED-97 with ISCED-11 can be found in Section 4.11. The following paragraphs discuss the alignment of ISCO with the 19th and 20th ICLS resolutions.

4.2.1. Aligning ISCO with the 19th and the 20th ICLS resolutions

83. In ISCO-08 the classification unit[59] is *Job,* where *job* is defined as "a set of tasks and duties performed, or meant to be performed, by one person, including for an employer or in self-employment" (ILO, 2012) (See § 41).

84. The 19th ICLS resolution I concerning statistics of work, employment and labour underutilization (ILO, 2013b) adopted an updated definition of the concept of job (See § 12) which was also used by the 20th ICLS Resolution I concerning statistics on work relationships (ILO, 2018b) where § 8 reads:

> 'A job or work activity is defined as a set of tasks and duties performed, or meant to be performed, by one person for a single economic unit.
>
> (a) The term *job* is used in reference to employment.[60] This statistical unit, when relating to own-use production work, unpaid trainee work and volunteer work is referred to as work activity.[61]
>
> (b) Persons may have one or several jobs during a given reference period. In statistics on employment, the main job is that with the longest hours usually worked, as defined in the current international statistical standards on working time. In the absence of information regarding hours usually worked, other information such as income from each job could be used as a proxy for identifying the main job.'

85. In aligning ISCO with the 19th and 20th ICLS resolutions, there is a need to assess the implications of these standards on ISCO regarding the definition of job and the relevance and suitability of using ISCO to code information in the case of work activities. It is also relevant to consider whether sub-major group 63 Subsistence Farmers, Fishers, Hunters and Gatherers should be maintained as such in the revised ISCO. Further detail is provided in the following paragraphs

A) The classification unit in the revised ISCO

86. **Suggested solution(s):** The TWG recommends updating the definition of *Job* in line with the definition used in the 20th ICLS resolution I, and the use of '*Job'* or '*Work activity'* as classification units or entities classified in the revised ISCO, which will be considered a single concept applicable to all *forms of work.* (See Box 4).

87. **Main arguments**: It is relevant to ensure the alignment and consistency of the ISCO with the latest and related international standards. By narrowing the concept of employment, the 19/20th ICLS Resolution I makes the ISCO-08 definition of job obsolete. Therefore, the use of the updated definition of job as well as the use of *job and work activity* as a single concept or classification unit in the revised ISCO address this problem. It entails applying the concept of occupation to *all forms of work* so that they can be classified by occupation using ISCO when needed.[62] In principle, a single activity at a time can be coded using ISCO, and not a combination of simultaneous activities.

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[59] According to the Generic Statistical Information Model (GSIM), (UNECE, 2016) a classification unit refers to the objects or units classified in a statistical classification.

[60] In the 19th ICLS resolution I, persons in employment are defined as all those of working age who, during a short reference period, were engaged in any activity to produce goods or provide services for pay or profit (see ILO 2013b § 27).

[61] In the 19th ICLS resolution I, persons in own-use production work are defined as all those of working age who, during a short reference period, performed any activity to produce goods or provide services for own final use (see ILO 2013b § 22).

[62] The definition of skills in ISCO would need to be amended to reflect the extension of the scope of ISCO to cover work activities.

88. Although ISCO-08 was designed primarily for the classification of information about jobs to produce goods or provide services for pay or profit, it can nevertheless be used to classify work activities in forms of work other than employment, as most forms of work can be adequately covered with some confidence in the framework of ISCO. Additionally, the use of ISCO, as a single set of occupational descriptions or system, to code all forms of work contributes to valuing the various forms of work other than employment and assigning an economic value to them. Additional clarification and arguments are outlined in the following paragraphs.

B) Coding cases of unpaid interns, trainees, and apprenticeships, volunteer and own-use production work using ISCO

89. **Unpaid interns, trainees, and apprenticeships**: Interns, trainees, and apprentices who work for pay in cash or in kind are considered in employment in the framework of the 19th ICLS resolution I (see § 30 (b)) and are considered employees in the framework of the International Classification of Status in Employment (ICSE-18) of the 20th ICLS (see §22) and could therefore be coded according to the most appropriate unit group in ISCO for which they are training for, based on tasks and duties they are performing. The nature of the transaction, being the absence of pay or profit in this case, should not lead to excluding their work activities from being coded using ISCO. This recommendation should not, in principle, have any impact on the revised ISCO or its national adaptation.

90. **Volunteer workers**: According to the ILO Volunteer work measurement guide (ILO, 2021)[63] findings from actual surveys demonstrate that volunteers commonly perform the same work activities without expectation of pay that employees or independent workers perform in exchange for pay or profit. Thus, it is possible to code volunteers' tasks using standard ISCO-08 methods (ILO, 2021,19).[64] The ILO Volunteer work measurement guide (ILO, 2021) and the ILO Manual on the measurement of volunteer work (ILO, 2011) recommend collecting information on the type of work undertaken by volunteers, which is considered crucial to integrating volunteer work into a more complete picture of the labour market and to assigning an economic value to their work. The manual recommends the use of ISCO (or its national adaptation) 'to code volunteering tasks, in a similar way to the use of this classification to code the tasks performed by those employed in paid jobs'. (ILO, 2021,19). The use of ISCO to code volunteer tasks 'can be easily linked to employment statistics, thereby enabling a more complex and detailed analysis of people's participation in different forms of work' and 'as wage statistics are often disaggregated by occupations classified according to ISCO-08, assigning ISCO-08 codes to volunteer activities facilitates the estimation of their market value. (ILO, 2021,19).[65]

91. **Own-use production work**: ISCO-08 may not be particularly well suited to the classification of work activities, and particularly cases of own provision of services[66] as defined by the 19th ICLS Resolution I (See § 22), specifically when persons are simultaneously engaged in multiple activities.[67] Various approaches were explored by the TWG on how to deal with these cases; however, no concrete recommendation is proposed yet as additional work is expected to be undertaken to solve this issue. This necessitates further exploration of options and/or the formulation of suitable guidelines; however, this was not considered by the TWG an immediate priority. Therefore, this work will be incorporated into the research agenda on the future of ISCO, which will be established to effectively handle outstanding issues. (See Section 5.3).

92. **County practices**: ANZSCO 2021 (Australia Bureau of Statistics (ABS), 2021) reads that it 'is not designed to cover work not undertaken for pay or profit, for example, voluntary work. However, this does not preclude ANZSCO from describing such activities. Interns, residents, and articling students are classified with their respective professional groups in the Canadian NOC 2021 (Statistics Canada, 2021) and the Singapore SSOC 2020 (Department of Statistics Singapore , Ministry of Trade & Industry, Republic of Singapore, 2020).

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[63] The document is available at: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/publication/wcms_789950.pdf

[64] The recommendation in the Manual is to collect response verbatim and to separately code each activity using ISCO.

[65] The manual provides examples of volunteering activities corresponding to ISCO-08 major groups.

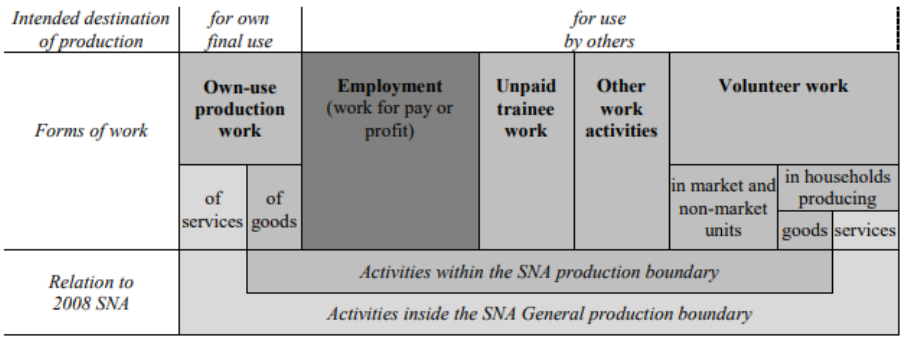
[66] Although ISCO-08 provides categories for domestic housekeepers, childcare workers, home-based personal care workers, and domestic cleaners and helpers, all of which are significant activities in both paid employment and own-use production of services.

[67] The 19th ICLS resolution § 22 (a) reads: '"any activity" refers to work performed in the various activities under paragraph 22(b) and (c) for a cumulative total of at least one hour.'

C) The status of sub major group 63 Subsistence Farmers, Fishers, Hunters and Gatherers in the revised ISCO

93. Sub major group 63 Subsistence Farmers, Fishers, Hunters and Gatherers was created in ISCO in the absence of any other international statistical instrument to allow measurement of subsistence activity. Additionally, according to the previous statistical standards (ILO, 1982), workers engaged in the production of goods for own or household consumption, including subsistence workers, were considered to be in employment. While own-use production work can in theory take place with respect to many types of goods or services associated with occupations in ISCO, the intended destination was only built into the definition and scope of sub major group 63 reflecting the fact that within farming and fishing it is particularly prevalent in some countries. However, the 19th ICLS resolution I defines five forms of work (See Box 4) and restricts the concept of *employment* to any activity to produce goods and provide services for pay or profit and uses *work activity* as a suitable concept to measure forms of work other than employment, making such a distinction irrelevant at the level of any specific group in ISCO as the form of work would make this distinction now. This calls into question the need for ongoing identification of subsistence agriculture as a separate sub major group in the revised ISCO, along with maintaining the market orientation restriction.

▶ Box 4 Forms of work and the System of National Accounts 2008



Source: The 19th ICLS resolution I concerning statistics of work, employment and labour underutilization (ILO, 2013b)

94. **Suggested solution(s):** The TWG does not recommend maintaining the market orientation restriction established within the scope of any group in ISCO, and therefore sub major group 63 will be discontinued from the revised ISCO, and its subsequent groups would be merged with corresponding groups in either sub major group 61 Market-oriented Skilled Agricultural Workers or sub major group 62 Market-Oriented Skilled Forestry, Fishery and Hunting Workers, as feasible.[68] Therefore, the revised ISCO would be used to classify all jobs and work activities without market orientation restriction specifically defined within the scope of any category. The 19th ICLS framework can be used to identify own production work, including subsistence farming, and produce related statistics.[69]

95. The impact of this recommendation would be small for most countries, as this group is not always used in national adaptations of ISCO. Noting that, if work activities in own-use production work are not classified by occupation, there may be no need to retain a category for subsistence farmers, fishers, hunters and gatherers, in the NOCs. Similarly, in some countries, subsistence farming may be rare or even non-existent, in which case there would be no need to include a group for subsistence activities in national adaptations of ISCO-08. Countries not yet implementing the 19th ICLS Resolution I framework and wishing to separately identify subsistence agriculture might wish to consider adding an additional question to survey instruments asking whether production is *mainly* for sale or *mainly* for own or family/household use. In terms of expected work to be undertaken to complete this change, some adjustments would need to be undertaken in ISCO and NOCs,

[68] The merging is possible as these groups have many tasks in common with market-oriented workers in groups found in sub major groups 61 and 62. Notes associated with Minor Group 921 Agricultural, Forestry and Fishery Labourers would also be reviewed to remove any market-orientation restriction.

[69] The use of the ILO LFS questionnaire '*Agriculture work start*' is designed to assist in collecting the needed data on own-production work for countries with high prevalence of small-scale own-account farming or fishing. It can be found at: https://ilostat.ilo.org/resources/lfs-resources/ .

these involve adjustments of sub major groups 61 and 62 group names (titles), to remove market restriction in instruments, material[70] and labels used, including in related databases, in addition to clear guidance on how to deal with these cases.

96. **County practices**: Regarding county practices, we note that groups equivalent to the ones identified under sub major 63 do not exist in either the ANZSCO (Australia Bureau of Statistics (ABS), 2021) or the Canada NOC (Statistics Canada, 2021) or the UK SOC (UK Office of National Statistics (ONS), 2020) or the Singapore SSOC (Department of Statistics Singapore , Ministry of Trade & Industry, Republic of Singapore, 2020), however, a similar group is found in many NOCs that are based on or aligned with ISCO-08.

97. **Comparison with options and recommendations from the 20th ICLS**: The alignment of ISCO with the 19th ICLS was not discussed during the 20th ICLS, however discontinuing sub major group 63 was recommended (see § 48), and this was supported by the Food and Agriculture Organization of the UN (FAO).

4.3. Major proposals to issues in relation to the ISCO-08 structure

98. A few proposals to address issues related to the ISCO structure were also made since June 2001. They are briefly listed below along with the proposed solutions. The TWG will continue the work related to improving the ISCO structure and other changes are expected to take place, including incorporating new and emerging occupations, providing the needed detailed categories, updating group descriptions for some categories, etc.

4.3.1. Recommendations involving treatment changes from ISCO-08

99. The TWG has addressed several group-specific issues listed in Room Document N.19 of the 20th ICLS (ILO, 2018a).[71] The subsequent paragraphs list issues for which the chosen approach differed from ISCO-08.

4.3.1.1. Specialist medical practitioners

100. The TWG recommends the breakdown of unit group 2212 as follows:

- 2212: Specialist medical practitioners
- 2213: Surgeons (new category, split off unit group 2212 in ISCO-08)

101. Therefore, the proposed categories for the minor group 221 Medical Doctors would be as follow:

- 2211: Generalist medical practitioner (unchanged)
- 2212: Specialist medical practitioners
- 2213: Surgeons

4.3.1.2. Biomedical Engineers

102. The TWG recommends the split of unit group 2149 Engineering professionals n.e.c and the creation of a new unit group 2147 Biomedical Engineers under minor group 214 Engineering Professionals (excluding Electrotechnology).

4.3.1.3. Epidemiologist

103. The TWG recommends moving Epidemiologists to unit group 2263 Environmental and Occupational Health and Hygiene Professionals.

4.3.1.4. Vehicle mechanics and accessory fitters

104. The TWG recommends adding a new unit group 7235 Tyre, exhaust and windscreen fitters, to minor group 723 Machinery Mechanics and Repairers. It was considered relevant to create one unit group for both jobs as

[70] This includes the index of occupational titles and the crosswalk between the two versions of ISCO or NOC.
[71] For a comprehensive understanding of each issue's essence within the categories outlined here, a detailed account can be referenced in Room Document N.19 of the 20th ICLS.

the number of workers in these jobs might not be large enough to warrant the provision of separate groups in many countries.

4.3.1.5. Home improvements installers

105. The TWG recommends adding a new unit group 7129 Building Finishers and Related Trades Workers n.e.c in minor group 712 for jobs that involve the installation of things like blinds, curtains, awnings, prefabricated doors and windows.

4.3.1.6. Company Secretaries and Corporate Governance Specialists

106. The TWG recommends moving this group from unit group 1211 Finance Managers as well as combining Company Secretary and Governance, Risk and Compliance Professionals together with ISCO unit group 2422 Policy Administration Professionals and reviewing group definition, tasks and duties.

4.3.1. Recommendations not involving treatment changes from ISCO-08

107. The following paragraphs outline recommendations not involving a change of treatment compared with the ISCO-08. A careful examination of various sources of information and options was undertaken by the TWG[72].

4.3.1.1. Oral and maxillofacial surgeons

108. Although in some countries Oral and Maxillofacial Surgeons (OMS) may be considered a medical specialization, the TWG recommends maintaining them within the unit group 2261 Dentists. However, the group title could be amended to reflect the inclusion of OMS and the group description could also be revised to reflect major OMS- specific tasks, if necessary.

4.3.1.2. Engineering Professionals

109. The TWG recommends maintaining the current treatment with minor groups 214 and 215, even though it recognizes that the current grouping might not be ideal, given the known boundary issue.

4.3.1.3. Armed forces occupations

110. The TWG recommends maintaining Major group 0 Armed forces occupations in ISCO with its current scope where military workers who perform typically military tasks, and other jobs undertaken by members of the armed forces (such as medical doctors, kitchen staff, truck drivers, etc.) would continue to be coded in existing unit groups of Major Group 0.

[72] For a comprehensive understanding of each issue's essence within the categories outlined here, a detailed account can be referenced in Room Document N.19 of the 20th ICLS.

5. The modernization of ISCO

111. The modernization of ISCO aims to introduce necessary approaches and activities to improve various aspects of the classification, including incorporating new and emerging occupations and addressing various issues as discussed in the previous chapters. Additionally, it involves proposals to maintain ISCO relevant between major consecutive revisions, to enhance its presentation and dissemination and to establish a research agenda on the future of the classification, which are discussed in this chapter. Overall, the goal of modernizing ISCO is to benefit from available technological advancements to ensure the classification responds to user needs and remains relevant and useful in a rapidly changing world of work.

112. While many of the proposals for modernizing ISCO are considered long-term plans and are subject to discussion at the 21st ICLS, nevertheless, some concrete work, including technical discussions and testing of options, was undertaken by the TWG or the office, as shown below and in Annex 2.

5.1. Maintenance and targeted ISCO updates

113. Since ISCO-68, the practice has been to revise the classification every 20 years. The ISCO revision is usually requested by the ICLS, and often, a working group is established to undertake and assist the ILO in the revision of ISCO.

114. This practice of revising ISCO at long intervals has certain advantages, such as maintaining classification stability over time and requiring fewer resources for implementation and adaptation at the national level. However, it does not support incorporating updates reflecting new and emerging occupations or other changes in the world of work that could take place in a such long-time frame. On the other hand, and given how rapidly such changes can happen, some aspects of ISCO can become outdated and lose relevance. This can impact the international comparability of occupational statistics if there is a lack of systematic and comprehensive guidance on managing these changes. For example, as illustrated in Box 5, the absence of guidance on addressing the case of "*Youtuber*", which emerged after the launch of ISCO-08, led to different solutions across countries.

▶ Box 5 Treatment of *Youtuber* in NOCs

Country	**ISCO code used by countries to code *Youtuber***
Country 1	Coded within 2513 Web and Multimedia Developers
Country 2	Coded within 2432 Public Relations Professionals
Country 3	Coded within 2641 Authors and Related Writers
Country 4	Coded within a different group within major group 3

Based on information collected during initial consultations within the TWG

115. In parallel, many countries and agencies have adopted interesting strategies to keep their classification of occupations relevant. These include one or more of the following: setting up a national revision strategy or plan; undertaking targeted updates; leveraging innovative technologies for classification updates; implementing improved communication mechanisms with users, etc. For example, a major NOC revision takes place every ten years, while a less comprehensive update takes place on a shorter term in a number of countries, such as in the case of Singapore SSOC (Department of Statistics Singapore , Ministry of Trade & Industry, Republic of Singapore, 2020), the Canadian NOC (Statistics Canada, 2021), the Korean KSCO (Korea Statistics, 2017), the US SOC (US Bureau of Labor Statistics, 2018), the UK SOC (UK Office of National Statistics (ONS), 2020), etc. [73]

116. The TWG discussed the importance of maintaining ISCO relevant between major revisions and the proposal related to periodic targeted ISCO maintenance was considered essential. It enables the classification to remain up-to-date and reflective of changes in the labour market. To this end, preliminary discussions have taken place

[73] This is based on publicly available information.

with the TWG to explore potential scenario and criteria that would warrant targeted ISCO maintenance. Additionally, the office has tested the feasibility of using new data sources to feed the ISCO maintenance (See 5.1.1 below and Annex 2 for more detail).

117. Under such an approach, a comprehensive revision of ISCO would continue to take place every 20 years and could include structural changes when needed, such as undertaking essential changes to the classification system, revising its conceptual approach, revising the skill levels of groups, etc. On the other hand, the periodic targeted ISCO updates or maintenance could consist of undertaking non-structural changes that will not alter the groups at aggregate levels, so they remain stable until the next major revision of the classification. This maintenance will focus on areas where changes are essential for the proper use of the classification. For example, this could include incorporating new and emerging occupations into existing groups, providing guidance on how to treat these, updating or drafting related group descriptions, updating the Index of occupational titles accordingly, etc.

118. Should such a proposal be endorsed by the 21st ICLS, it will undoubtedly help countries anticipate and plan for necessary modifications and prepare requirements for implementation more consistently and in a more synchronized manner.

119. The office is aware of the resources required to undertake this change as well as its potential impact on classification stability and comparability with previous statistics. Therefore, pending views from the 21st ICLS, the TWG could assess in greater depth both the nature of the updates that could be undertaken through more regular targeted updates and the means to achieve this. The TWG will ensure that country practices are examined for this purpose and an appropriate maintenance cycle is proposed. These technical aspects could be drafted in the form of a more concrete proposal for discussions at the 22nd ICLS.

Requirements of the successful maintenance and targeted updates of ISCO

120. A successful implementation of the targeted ISCO updates would need to be based on solid arguments and key principles would need to be drafted to ensure a proper functioning of the process. Additionally, it requires anticipating some activities and actions, including the availability of essential data sources, establishing relevant governance for ISCO, and putting in place a versioning protocol, which are briefly described below.

5.1.1. Essential data sources

121. As with current practice, the ISCO revision would continue to rely on advice from a group of experts and information available from recently updated NOCs. Therefore, any future proposal on the timing or nature of the ISCO targeted update will mainly depend on the data and information available from NOCs. Additionally, a literature review and ad-hoc consultations will be considered in the targeted update and maintenance of the ISCO.

122. Considering the rapid technological advancement and the availability of large amounts of data sources, it was crucial to explore new avenues for keeping ISCO up to date. Therefore, in 2022, the office, in collaboration with the Ministry of Manpower of Singapore, established a Memorandum of Understanding (MOU) to initiate a proof of concept (POC) focused on leveraging artificial intelligence (AI) and new data sources that could be used in future targeted and periodic ISCO maintenance.

123. The project engaged specialists from both organizations to test the feasibility of collecting data on online job vacancies through web scraping as well as data made available by a job board through an existing partnership agreement. The POC involved the use of Machine Learning (ML) and Natural Language Processing (NLP) techniques to breakdown the vast amount of data in order for it to be used for analysis.

124. The POC developed a New and Emerging Occupation composite index which estimates the likelihood of a job title being a new and emerging occupation candidate. To ensure that these candidates exist in various countries/regions around the world, the job titles were cross-checked against ISCO and a variety of recently updated National and Regional Occupational Classifications (NOC/ROCs) using semantic textual similarity. Candidates surfaced for the revision of ISCO would be validated by classification experts.

125. The outcome of this POC also demonstrated that the ISCO Index could also be updated. Additionally, other useful information was detected, including required skills, for example. The 'clustering' techniques, which were used to group together job titles that were identified through the POC, have the potential to facilitate the process of identifying the 'closest group' or 'best fit' to incorporate these titles within the ISCO structure.

126. As a conclusion, the project noted that such a methodology could be applied to future periodic ISCO maintenance, provided that the needed technical and human resources are available.[74] For further details about the POC please refer to Annex 2 where the methodology and results are discussed in detail.

5.1.2. Governance of the ISCO

127. So far, the practice to revise the classification has been to establish a working group to undertake and assist the ILO in the revision of ISCO. This is not proposed to change. However, while the working group can only be established to undertake a major revision of ISCO over a long period of time, the maintenance of the classification requires having in place a smaller group of experts to undertake this mission between major consecutive revisions of ISCO. Therefore, pending views from the 21st ICLS on the relevance of the targeted ISCO update and maintenance, an 'advisory committee' could be established following the 22nd ICLS to assist the ILO in managing and implementing this maintenance and to define how the process of the modernization of ISCO could be carried out in a collaborative and transparent manner that is reflective of issues and concerns in ISCO.

128. The '*advisory committee*' could be formed from a limited number of ILO constituents, with representation from governments, employers, and workers organizations, as well as a number of observers or experts. It can be led by the ILO and co-led, on a rotational basis, by one or more countries. Ad-hoc experts or agencies can be invited to take part in the advisory committee meetings or consultations, as needed. This advisory committee will be part of a working group that will have additional members and become operational when a major revision of ISCO is undertaken.

129. The mandate of the '*advisory committee*' can be focused on i) providing support and decision-making as part of a transparent maintenance mechanism for ISCO; ii) providing advice to the ILO on issues in ISCO along with proposing appropriate recommendations; iii) receiving and resolving queries; and iv) identifying areas requiring updates as part of a research agenda to improve ISCO. Specific Terms of Reference (TORs) of the advisory committee can be drafted in line with the proposed general mandate if the proposal is considered relevant by the 21st ICLS.

5.1.3. Versioning protocol of the ISCO

130. Pending views from the 21st ICLS on the relevance of the targeted ISCO update and maintenance, it is essential that any released update be accompanied by a systematic versioning protocol of ISCO, allowing users to identify the state of the modification and its nature and enabling them to track and implement changes accordingly in NOCs.

131. The semantic versioning (Semver, n.d)[75] will be assessed for relevance and feasibility. This protocol could also be aligned with or inspired by the Generic Statistical Information Model (GSIM) (UNECE, 2016) terminology and documentation that are applicable to statistical classifications.

[74] For instance, our technical needs could include sophisticated data processing infrastructure and platforms capable of extensive text mining, such as Azure, Google Cloud and AWS. In terms of personnel, it's essential to have experts proficient in web scraping, AI, ML and NLP.

[75] Which is a versioning management protocol

5.2. Innovative and new presentation of the ISCO structure and materials

132. The modernization of ISCO also envisages a new presentation of the classification's structure, which entails a different presentation of groups. It consists of clustering unit groups in a thematic view or in clusters that cut across skill levels, or regardless of the skill levels of an occupation. In other words, it allows putting together unit groups that are similar based on a specific topic or skill specialization such as science, technology, engineering, and math (STEM) occupations, health occupations, tourism occupations, ICT occupations, agriculture occupations, etc. This will facilitate the analysis and coding of occupations.

133. Specific clusters would need to be assessed and proposed by the TWG, and maybe in consultation with other groups, agencies, or experts based on their relevance and use in areas where there is a known demand for statistics on specific topics. The development of these clusters could begin after the launch of the revised ISCO. At this stage, the TWG can only gather input from users of ISCO regarding potential clusters that might be developed in the future, as this information might be considered during the revision of the ISCO structure, especially if specific grouping or disaggregation of categories are needed.

134. Additionally, ISCO material shall be available in the future in a user-friendly and digitally searchable format, facilitating data and metadata linking, sharing, and exchange, aiming at maximizing its use and integration in various operations.

5.3. Establishing a research agenda on the future of ISCO

135. The TWG discussed the relevance of putting in place a research agenda on the future of ISCO. The agenda would examine outstanding areas requiring improvement that might not be addressed within this round of revision. For example, it will serve to identify appropriate means for coding cases of own-production work or any skill-related issue that might not be fully resolved, etc.

136. The agenda also aims to collect issues that would not be addressed as part of a targeted update or maintenance of ISCO and to initiate discussions around major future changes in ISCO. This could include collecting feedback and advice on the continuous technical and conceptual improvement of ISCO, anticipating the classification system change, identifying options related to the code sequence limitation in ISCO, etc. Other topics can also be included as part of the future agenda; they can take user needs into account.

6. The way forward

137. The revision of ISCO-08 will continue after the 21st ICLS meeting, with the aim of completing it on time for the next round of housing and population censuses taking place in 2030. Input from conference delegates will be taken into account to steer and finalize the work.

6.1. Required activities to complete the ISCO-08 revision

138. As mentioned elsewhere in this document, there are several pending issues that the TWG will continue addressing to complete the revision of ISCO. Alongside issues that were identified in Room Document N.19 of the 20th ICLS (ILO, 2018a), the TWG envisages addressing a larger list of concerns that were received or collected from countries and other users after the 20th ICLS or were identified by the TWG, including any outstanding issues that could have been mentioned in the survey of country practices review conducted by the office prior to the 21st ICLS.

139. For example, the revision of skill levels of various categories is envisaged. In addition to the list of categories that was included in Room Document N.19 of the 20th ICLS (see § 81-82), another group of categories will undertake a similar assessment of skill levels in light of the proposed changes and pending discussions at the 21st ICLS. This needs to be done to reflect the change in the measurement and application of skill levels as a classification criterion and the boundary change between Skill Levels 2 and 3 or as a consequence of the change in skills since ISCO-08 was launched. Additionally, the TWG will continue the necessary work to finalize the skill levels framework, including determining the criteria related to '*other forms of training/learning*' and its measure.

140. The work on improving the structure of ISCO, such as assessing the need for greater detail and incorporating new and emerging occupations, particularly in ICT occupations, has started but is yet to be completed. SWG1 has identified several groups requiring amendment. Treatment of obsolete categories is also envisaged as part of the work to revise and improve the ISCO structure.

141. Furthermore, SWG2 has made some concrete proposals to improve group descriptions and related notes, as some became outdated, and others would need to be amended or drafted considering any change in the structure. However, this work is not yet completed. This task shall also include work on clarifying the treatment of some categories, such as the case of information and communications technology specialists and social media and e-commerce, or the clarification between supervisory and managerial occupations and operators of small businesses, etc.

142. Depending on the discussions that could take place at the 21st ICLS, SWG3 will continue the work related to the modernization of ISCO.

143. Required methodological material, including the revised ISCO conceptual approach, major changes with ISCO-08, useful guidelines and principles, updated definitions, updated Index of occupational titles, etc, necessary for implementation of ISCO, will be developed in preparation for the launch of the revised classification.

144. Subject to resource availability, the office plans to adopt a flexible mode of engagement with the TWG, combining face-to-face and hybrid meetings. Regular online working sessions and consultations will continue to take place as needed. When needed, ad-hoc consultations with experts, associations and agencies could also be undertaken. Regional online meetings may be organized to reach out to more countries, share updates on the ISCO revision and collect regional or specific feedback on these.

145. A list of major activities to be undertaken to complete the revision of ISCO and a timetable are proposed in the table below.

▶ **Table 5 Timetable and proposed major activities to complete the revision of ISCO**

Time frame	Major activities
2023- 2025	• Continue addressing major outstanding issues in ISCO (including the ones that were identified in the 20th ICLS and additional ones that were collected by the office or suggested by the TWG). • Undertake the necessary research and analysis to develop an updated structure of ISCO • Prepare for and undertake global consultations on the proposed draft structure and major proposed modifications to ISCO • Analyse and incorporate the feedback collected from the global consultations
2026-2027	• Updated group descriptions, scope and notes • Prepare for and undertake necessary consultations on the group descriptions, scope, etc. • Analyse and incorporate feedback collected from these consultations • Draft necessary methodological material, including the ISCO conceptual approach, major changes with ISCO-08, guidelines and principles, etc. • Making the Index of occupational titles and the crosswalk between ISCO-08 and the revised ISCO available
22nd ICLS	• Finalize the draft resolution and the necessary related material • Organize a Meeting of Experts around the draft revised ISCO • Incorporate the comments and feedback from the meeting of experts • Finalize necessary documentation, including a resolution for adoption during the 22nd ICLS meeting and other essential material

6.2. Activities following the launch of the revised ISCO

146. A number of activities are also planned to follow the launch of the revised ISCO and consist of the following:

- Make the classification publicly available in a user-friendly format on the ILO Stat website.
- Develop *'ISCO companion guide'* to assist countries in the implementation of the revised classification and provide assistance and training on the classification explaining major changes between the two versions of ISCO
- Undertake the work on the job families/ job clusters
- Develop ISCO material in the official languages of the ILO (French and Spanish)
- Depending on the discussions at the 21st ICLS meeting and the availability of resources, start implementing the needed infrastructure and activities for the modernization of ISCO.

6.3. The needed resources to complete the ISCO-08 revision

147. It is important to note that the successful implementation of many activities to complete the ISCO revision including the modernization projects of ISCO relies on the availability of resources as well as further analysis and development.

148. The TWG, recognizes that resources are required for this undertaking, and on the basis of their availability, certain activities may need to be postponed to another revision cycle. And as can be seen from the extensive range of issues that need to be addressed, some prioritization may be required to ensure a revised ISCO can be presented for discussion at the 22nd ICLS. This prioritization will be discussed with the TWG, considering available resources and informed by the input of delegates at the 21st ICLS. This *may* necessitate the postponement of some activities to later rounds of revisions.

149. Joint efforts, collaborations, or partnerships might provide a helpful solution to the scarcity of resources. Delegates attending the conference are encouraged to provide feedback on the proposed activities' relevance so that the prioritization of the work will be guided by these discussions and further engagement with the TWG, and therefore the TWG could propose concrete actions for their implementation, which could be discussed at the 22nd ICLS.

7. Conclusions

150. This room document presented the main recent developments following the 20th ICLS and the progress of work related to the revision of the ISCO, which started in June 2021 and is foreseen to be completed on time for the next round of housing and population censuses taking place in 2030.

151. While several issues have been discussed and resolved within the TWG, there are still many complex issues and concerns to address in ISCO. The work on the ISCO revision will continue in the coming years, as described in the previous section.

152. Based on the discussions at the 21st ICLS, the TWG will revisit the list of issues, prioritize them, and address most of them within the proposed time frame, however, some others might be postponed to any future revision of the classification. Such a prioritization will be guided by considerations of technical feasibility and resource requirements.

153. Participants at the conference may wish to consider the main proposed recommendations and solutions to resolved issues in ISCO, as outlined in the previous sections of this room document, and provide feedback on their appropriateness, as well as providing advice on the relevance of the modernization projects of ISCO.

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9. Annexes

Annex 1 List of members of the Technical Working Group (TWG)

REPRESENTING GOVERNMENTS	REPRESENTING THE EMPLOYERS
Argentina	Australian Chamber of Commerce and Industry
Australia	Asociación de Azucareros de Guatemala
Bahrain	
Brazil	REPRESENTING THE WORKERS
Canada	Australian Council of Trade Unions
Chile	Fédération des Médecins Résidents du Québec
China	
Colombia	REPRESENTING OBSERVERS
Dominican Republic	Economic and Statistical Observatory for Sub-Saharan Africa (AFRISTAT)
Eswatini, Kingdom of	European Skills, Competences, and Occupations (ESCO)
Ecuador	Statistical office of the European Union (EUROSTAT)
France	European Training Foundation (ETF)
India	The Food and Agriculture Organization (FAO)
Iraq	The statistics Department of the Gulf Cooperation Council (GCC-STAT)
Italy	Pacific Community
Jordan	The United Nations Economic Commission for Africa (UNECA)
Korea, Rep. Of	United Nations Economic Commission for Latin America and the Caribbean (UNECLAC)
Lesotho	United Nations Industrial Development Organization (UNIDO)
Madagascar	United Nations Statistics Division (UNSD)
Maldives	The World Health Organization (WHO)
Mexico	ILO Bureau of Employers' Activities ACT/EMP
Morocco	ILO Bureau of Workers' Activities ACTRAV
Netherland	
New Zealand	
Pakistan	
Rwanda	
Saudi Arabia, Kingdom of	
Sri Lanka	
Sweden	
Switzerland	
Tanzania	
Tunisia	
United States of America	
United Kingdom	
Uruguay	
Viet Nam	

Annex 2: A feasibility study on identifying new and emerging occupations candidates using data from online job advertisements to support the revision of ISCO-08[76]

Introduction

Globalisation, climate change, demographic shifts and the fourth industrial revolution have continuously transformed job requirements and led to the creation of entirely new job roles due to the evolving needs of the labour market. The COVID-19 pandemic has roiled the labour market and the economy has undeniably taken a hit. Industries and companies throughout the world have been challenged, driving unprecedented changes in the way businesses and consumers react and behave. For labour market information systems to keep pace with these developments to facilitate informed decision making by policy makers, education and training institutions, businesses and individuals, there is an urgent need to obtain information quicker and with more granularity.

This paper presents an approach at identifying new and emerging occupations based on data from online job advertisements to facilitate the updating of the International Standard Classification of Occupations (ISCO, version 2008). Utilising a combination of supervised and unsupervised learning techniques, we introduced a novel composite index that merges predictive probabilities from an occupation classification model with a term importance metric. As a result, 288 potential new and emerging job candidates were successfully identified from 1,653,699 unique job records sourced from various web portals. The rest of the paper is organised as follows: **Section 1** discusses the methodological approaches used and key considerations in identifying new and emerging occupations candidates. **Section 2** evaluates the benefits and limitations of our approach. **Section 3** seeks to summarise the main key takeaways with suggestions on possible improvements.

1 Methodology

1.1 Data

Data from online job advertisements was collected via web-scraping from online job portals as well as through a data sharing partnership arrangement between the International Labour Organization (ILO) and Uruguayan online job board BuscoJobs[77].

Web-scraped[78] data included both general and niche online job portals that collated information from thousands of different sources. The latter included job advertisements related to social welfare (e.g. Idealist) or technology (e.g. Nodeflair). The inclusion of niche job portals allows a more comprehensive understanding of the job market, providing valuable insights into the hiring trends and demands within those specialised fields.

We chose to web-scrape certain job portals/aggregators due to several reasons. Firstly, the webpages were easier to scrape, which allowed us to efficiently gather the data we needed. Secondly, our variables of interest were readily available and in a granular format. Lastly, the job portals/aggregators we chose had a wide geographical coverage, which allowed us to collect data from various regions.

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[76] This annex was prepared by Ng Bin Shen Lucas, Eldwin Lee, Sim Tze Wei Daniel, Chen Zhihan from Manpower Research and Statistics Department, Ministry of Manpower Singapore. Lara Badre (Senior Statistician) and Shutong Ding (Statistical Knowledge Management Officer) from the ILO Department of Statistics provided input to it and offered methodological guidance.

[77] BuscoJobs is a private job board containing information from both supply (i.e applicant profiles, resumes, applicant job applications) and demand (i.e establishment profiles, job vacancy listings).

78 The rules specified within the robot.txt file per website was strictly adhered to.

Data ranged from August 2022 to January 2023 with a total of 243,317 records. Job relevant data fields include job title, job description, advertised salary, education and work experience requirements while employer relevant data fields include hire name and industry. Some job advertisements may also provide skills requirements and/or whether the possibility of remote working is available.

Data from BuscoJobs refer to job postings in the month of May 2022 from 6 countries (India, Australia, South Africa, New Zealand, Philippines and Kenya) with a total of 1,742,891 records, consisting of the following variables: (1) job title; (2) job description; (3) salary information; (4) country specific information (country, city, administrative division); (5) number of applicants; (6) hire name and (7) skills requirements[79]. The 6 countries were chosen as English was the predominant language of choice.

1.2 Data preparation

Data cleaning of online job advertisements (OJAs) involves the dropping of missing values (i.e job title, job description) and de-duplication of records using a combination of job title, job description and hire name. While some job descriptions were in other languages, this analysis focused solely on OJAs written in English. The *langdetect* library in Python, a re-implementation of Google's language detection library from Java to Python was used to facilitate the categorisation of job postings based on the language of the first 50 characters in the job description.

Custom text cleaning functions[80] and text pre-processing techniques such as stop word removal, including the mapping of common abbreviations[81] to its full form using a custom curated dictionary was applied on the job titles and job description. The final dataset comprised 1,439,789 unique job advertisements from BuscoJobs and another 213,910 from various online job portals. **Table 1** provides the breakdown of the original and processed number of observations by data source and country.

Table 1. Breakdown of dataset by source, job portal, by country

Data web-scraped from Online Job Portals		
Country	**Number of Job Postings (Original)**	**Number of Job Postings (Processed)**
Singapore	123,431	123,309
Malaysia	65,653	61,059
Indonesia	38,647	14,289
Singapore	8,053	8,051
International	7,533	7,202
Total	**243,317**	**213,910**

[79] Comprises a total of 188 unique specialised/technical skills and broad skill groups such as C#, FoxPro, PHP, data analysis, accounting.

[80] Includes the substitution of ['and' with '&', '-' with '_'], the removal of ['part-time' or 'full-time', text bounded between '()' or '[]' or '| |', words containing only numeric characters, text following after '#','$','@'], retaining words with more than or equal to 2 characters.

[81] These included abbreviations such as {snr. : senior, jr. : junior, mgmt. : management, dev. : developer}.

Data from BuscoJobs		
Country	**Number of Job Postings (Original)**	**Number of Job Postings (Processed)**
India	800,000	628,559
Australia	550,184	474,129
South Africa	218,633	177,776
New Zealand	115,438	108,073
Philippines	47,969	41,373
Kenya	10,667	9,879
Total	**1,742,891**	**1,439,789**

From the 1,653,699 processed records in **Table 1**, we constructed two datasets. The first consists of distinct job titles and job description while the second consists of distinct job titles. The job titles in the second dataset were further processed using Spacy, dropping named entities that are countries/cities/states, cardinal numbers and dates as these entities have no added value to the process. This results in 481,326 distinct cleaned job titles (CJT).

1.3 Occupation classification NLP model

We fine-tuned a pre-trained natural language processing (NLP) model to provide a 4-digit ISCO code for each observation in the first dataset.

The NLP model relies on the Bidirectional Encoder Representations from Transformers (BERT), a pre-trained[82] language model developed by Google in 2018 by Devlin et al. (2019). BERT is a deep learning model that uses the transformer architecture to compute vector-space representations of natural language that are suitable for use in deep learning models. The transformer architecture is built on special layers called attention layers that enables the model to pay attention to specific parts of a sentence and capture the context and meaning of words within a sentence. Since then, there have been several other BERT models (e.g ALBERT, DistilBERT, RoBERTa) aimed at lowering memory consumption and improving training time at a cost of model performance.

1.3.1 Data used for supervised learning

Fine-tuning the BERT classification model requires text data paired with predefined classification labels. We rely on data collected through labour force and establishment surveys by the Manpower and Research Statistics Department (MRSD) of the Ministry of Manpower Singapore using the job title and job description of persons in employment. The most appropriate occupation code based on the Singapore Standard Occupational Classification (SSOC, version 2020), which adopts the basic framework and principles of ISCO was assigned by a trained interviewer. The occupation code assigned is further verified by a team of verification officers to ensure accuracy and consistency. Since 2019, MRSD has deployed the use of an autocoder to provide the top 5 SSOC codes, along with their prediction probabilities to verification officers to simplify the process of assigning an occupation code.

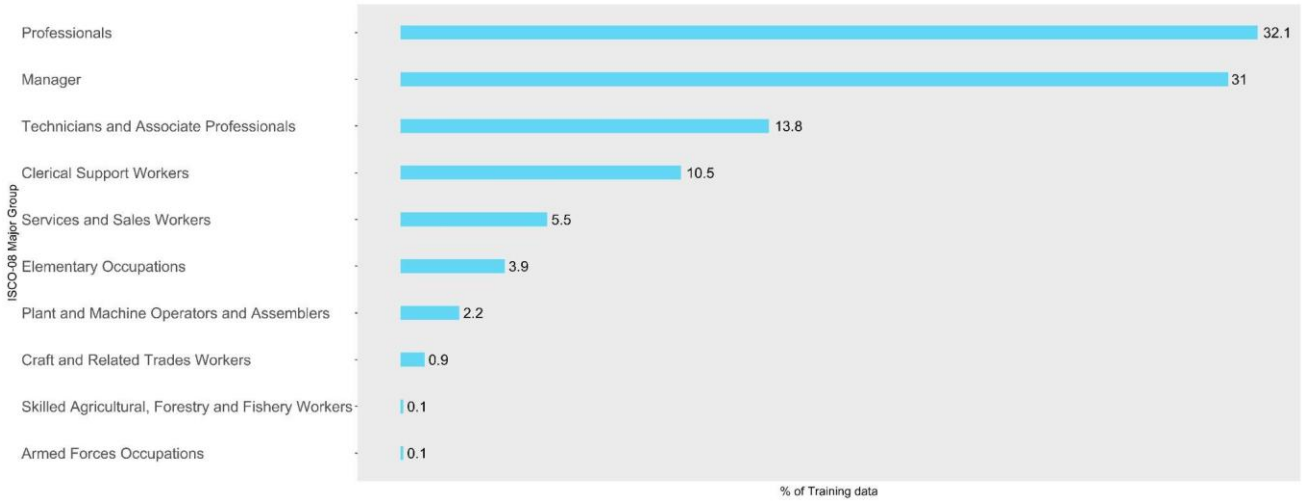
[82] Self-supervised learning on unlabelled data from Wikipedia (~2.5 billion words) and the BooksCorpus (~800 million words).

To obtain a corresponding ISCO code, we mapped the SSOC occupation codes using a correspondence table[83] developed by the Department of Statistics Singapore.

1.3.2 Training and evaluation of classification model

We adapted the BERT-base uncased architecture to fine-tune it on the MRSD dataset composed of job titles, job descriptions, and corresponding ISCO codes. The data, which contains 503,573 records, was split into an 80% training set and a 20% test set stratified by ISCO's 1-digit major group classifications. The occupation distribution of the training set is provided in **Figure 1**. Next, we fine-tuned the model on the training set using its default hyperparameters, but with a lower learning rate of 2e-5 to mitigate the issue of catastrophic forgetting. To address class imbalance, occupations with many records were assigned a lower class weight while occupations with lesser records have a higher class weight.

Figure 1. Occupation distribution of the training dataset



Note: Data may not add up to 100% due to rounding.

An objective evaluation of the model was carried out by predicting it on the test set using the F1-score[84] which harmonises both precision[85] and recall[86]. We derived the F1-score per ISCO 4-digit code in a one-vs-rest manner, yielding a total of 364 F1-scores. Next, we aggregated the F1-scores to ISCO 1-digit by taking a simple average. To represent the overall performance of the model as a single measure, we aggregated the F1-scores at ISCO 1-digit using a weighted average on the support of each class, yielding the value of 0.56.

1.4 Identifying new and emerging occupations

For the purpose of this feasibility study, a new and emerging occupation candidate refers to new, frequently advertised jobs which are substantially different from occupations already captured in ISCO. Our goal is to identify potential candidates that may be emerging occupations and surface them for human validation.

To better understand and categorise these 481,326 CJTs, we adopted a multi-pronged approach that combines both supervised and unsupervised learning techniques. We began by converting these textual job titles into numerical representations, or embeddings, using the FastText word embedding technique. This was further enhanced by introducing a composite index that blends the predictive probabilities from an occupation classification model in section 1.3 and a metric known as 'Revealed Comparative Advantage' (RCA). RCA calculates the significance of

[83] https://www.singstat.gov.sg/standards/standards-and-classifications/ssoc
[84] The F1 score ranges between 0 to 1. Typically, values between 0.5 to 0.8 are average, 0.8 to 0.9 are good and values above 0.9 are very good.
[85] Among the predictions that were made, how many are truly positive.
[86] Among the actual positive examples out there, how many of them were correctly predicted to be positive.

specific terms in a job title relative to their appearance across all job titles. In essence, our method involves translating job titles into a form machines can understand, then evaluating and comparing them using a combination of predictive modelling and term importance metrics. As a final validation step, we cross-validated our findings against established National Occupation Classifications (NOCs) and Regional Occupation Classifications (ROCs) to ensure the accuracy and relevancy of our results. This holistic strategy ensures that we capture the essence and nuances of emerging occupations and align them with existing benchmarks.

1.4.1 Word and sentence embeddings

To analyse the job titles, a numeric representation (i.e an embedding[87]) for each word needs to be derived. Such a representation has an added benefit of comparing how similar or different is a word to another using measures such as cosine similarity. There exist several ways to do this ranging from less complex methods such as bag-of-words/one-hot encoding that simply counts the number of occurrences or assigns a value 1 in the position corresponding to the index of the word in the vocabulary and 0 elsewhere. These methods do not account for the context of the words and often have sparse representations, especially for large corpuses with several unique terms, leading to memory issues and inefficiencies. Other techniques derive word embeddings using more complex algorithms such as the Global vectors for word representations (GloVe; Pennington et al., 2014) and word2vec that utilises either the continuous bag-of-words (CBOW) or continuous skip-gram (SG) model architectures.

Giabelli et al. (2021) compared the performance the GloVe, word2vec and FastText in synthesising word embeddings required for their task of automatically enriching the European Occupation and Skill Taxonomy with terms that represents new occupations extracted from OJAs. The experimental results concluded that the best performing model was FastText. Given this, we rely on FastText, an extension of the word2vec continuous skip-gram approach which frames the problem of predicting context words as a set of independent binary classification tasks, effectively using subword information. Modifications were made to the scoring function of skip-gram to take into account the internal structure of words, represented as the sum of the vector representations of its character n-grams. For example, the word “where” would be represented as the average of its character n-grams represented as <wh, whe, her, ere, re, where>. As such, FastText is robust to out-of-vocabulary words and takes into account morphology (e.g ice and icy are morphologically related), an important consideration for our use case.

A FastText continuous skip-gram word embedding model[88] was trained on the 481,326 distinct CJT. In order to evaluate the quality of the word embeddings obtained, we measured the semantic similarity using the SimLex-999 dataset (Hill et al., 2014) which contains two sets of english word pairs along with human-assigned similarity judgements. Performance is evaluated by maximising the spearman’s rank correlation coefficient between human judgement and the cosine similarity between the word embeddings. The iterative process involved training and evaluating the model with various permutations of hyperparameters, optimising them in the following order of importance: (1) minimum length of character n-grams, (2) maximum length of character n-grams, (3) the maximum distance between the current and predicted word in a sentence, (4) the number of epochs. The final hyperparameters chosen were 2, 6, 3 and 100 respectively. To obtain the sentence embedding of each job title, we simply took a simple average of the word embeddings obtained.

1.4.2 Dimension reduction and clustering

With the aim of improving the performance and accuracy of clustering algorithms by lowering the amount of noise and redundancy and negate the risk of overfitting (Howley et al., 2006), we reduced the dimensions of the OJAs by sentence embedding matrix using Uniform Manifold Approximation and Projection (UMAP)[89], a non-linear algorithm that seeks to find an embedding by searching for a low-dimensional projection of the data that has the closest possible equivalent fuzzy topological structure. It has the benefit of both preserving and capturing the

[87] Refers to a mapping of discrete or categorical variables to a vector of numeric values.
[88] Word vector dimensionality of 300, learning rate of 0.1, minimum count of 5
[89] UMAP requires the prespecification of the number of neighbours used for manifold approximation as well as the number of components (i.e dimension of the space to embed to).

global structure of the data better while maintaining the local structure as compared to algorithms such as principal component analysis (PCA) or non-negative matrix factorization (NMF) (McInnes et al., 2020) that assumes that linear relationships exist among the variables. A drawback of using UMAP involves the computation time required. The default implementation of UMAP quantifies the distance between observations using euclidean distance. Aggarwal et al. (2001) showed that in a high-dimensional space, the data becomes sparse, as such the concept of proximity or distances becomes less meaningful, cautioning against the use of euclidean distances. Following this, we adopted the use of cosine distances which has also been shown to result in an embedding of higher quality that performed better (Winderbaum et al., 2015; Smets et al., 2019).

Next, we clustered the sentence embeddings with the wishful thinking that job titles that are largely similar are placed close together within the vector space, reflecting latent occupation groupings such as information and communications technology (ICT) job roles, engineering related job roles or healthcare professionals. There exist several methods to cluster data with high dimensions such as graph-based clustering, hierarchical clustering (i.e agglomerative or divisive approaches), partition-based clustering (i.e K-means, K-medoids, CLARA) and density-based clustering (i.e DBSCAN, HDBSCAN). For our analysis, we adopted the use of the Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN; Campello et al., 2013) algorithm with manhattan distance as it is less sensitive to outliers and is able to deal with arbitrarily shaped clusters with varying densities.

In order to select the optimal hyper-parameters for UMAP and HDBSCAN, we fine-tuned the number of neighbours as well as the number of components for the former, and the minimum cluster size as well as the number of minimum samples for the latter. To assess the performance of a given set of hyperparameters, there is a need to specify an objective function to minimise. An option was to minimise the ratio between the average intra-cluster and average inter-cluster distance (i.e silhouette score), a commonly used metric for partition-based clustering techniques. However, this is not applicable for density-based clustering approaches as it is incapable of handling outliers. Instead, we maximise the density-based clustering validity score (DBCV[90]) which evaluates the clustering quality using both density and shape through the building of Minimum Spanning Trees (Moulavi et al., 2014), constrained on the postulated total number of clusters based on domain knowledge[91]. The process of finding the optimal hyperparameters was facilitated using bayesian optimization[92], using the *hyperopt* library in Python. Bayesian optimization uses results obtained from historical searches to improve search speed through the building of a probabilistic model that is less costly to evaluate to represent the objective function (i.e surrogate model). This was searched efficiently with the help of an acquisition function whose purpose is to evaluate the utility of the next set of hyperparameters to consider, given existing knowledge. We ran the optimization for 30 iterations and obtained the following optimal hyperparameters: (1) number of neighbours: 13, (2) number of components: 64, (3) minimum cluster size: 902 and (4) minimum number of samples: 58 with a DBCV of 0.252, yielding a total of 89 clusters.

To visualise a high-dimensional object in 2D, dimension reduction techniques like t-SNE (Maarten & Hinton, 2008) or UMAP are essential. We adopt the use of UMAP due to its competitiveness against t-SNE, its ability to scale to larger dataset sizes and properties of superior run-time performance (McInnes et al. 2020). Using the reduced vector space matrix of $481{,}326 \times 64$ as our starting point, we first computed a sentence embedding for each cluster (i.e cluster centroid) by taking a simple average of all observations within a cluster. Next, we further reduced the 89×64 matrix into 2-dimensions using UMAP[93] and plotted the results in **Figure 2**.

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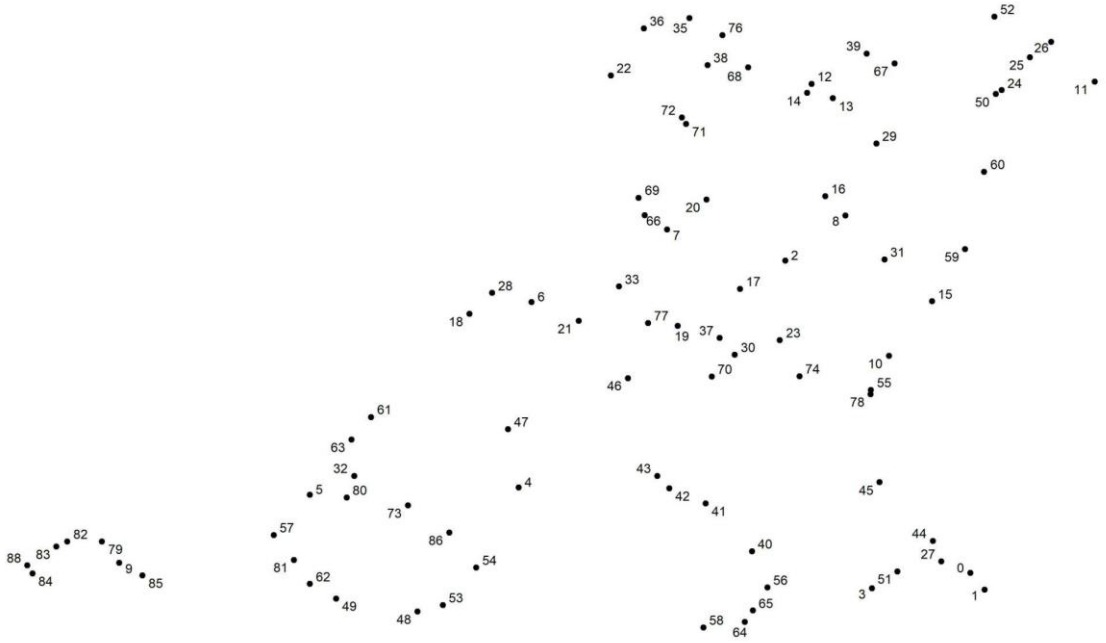
[90] DBCV ranges between -1 to 1 with greater values of the measure indicating better density-based clustering solutions.

[91] We postulate that the number of clusters assigned (NCA) should fall within: number of distinct 1-digit ISCO code (9) < NCA < number of distinct 4-digit ISCO code (288) as predicted by the classification model fitted.

[92]The Tree-structured Parzen estimator approach was used with the Expected Improvement (EI) acquisition function. The search space is given by: 10<=number of neighbours<=100, 2<=number of components<=100, 600<=minimum cluster size<=100, 10<=minimum number of samples<=500.

[93] Number of neighbours=5 was used to obtain a view that balances the local and global tradeoff.

Figure 2. Visualisation of cluster centroids



Note: Refer to Annex A for more details. Clusters 34, 75 and 87 were dropped as they contained overlapping latent occupational constructs which were not meaningful for further analysis.

As seen from **Figure 2,** with reference to **Annex A**, clusters are formed likely due to the presence of certain keywords or phrases for example, the keyword ‘stack’ in cluster 82, ‘salesforce’ in cluster 5, ‘sap’ in cluster 61 and ‘talent acquisition’ in cluster 14. They also group together occupations with similar job functions (i.e machine operators and drivers, supply chain management, procurement, accounts, audit, customer relationship, policy, occupational safety and health), tools and technological platforms/company names popularised by their softwares (i.e salesforce, sap, .NET) and occupations (i.e tutor, teacher, accountant, nanny/baby-sitter). As such, clusters reflect a variety of latent constructs and have to be interpreted independently.

The distance between clusters provides an indication of how similar or different one cluster is from another. From **Figure 2**, clusters with occupations requiring technical knowledge of general-purpose programming languages such as PHP, C++, C#, Java and frameworks such as .NET for the development of softwares are all clustered together at the bottom-left corner (clusters 9, 79, 82, 83, 84 85, 88). Similarly, occupations related to software testing such as user acceptance testing (UAT) and quality assurance testing (QAT) lie close to each other (clusters 48, 53, 54). Also, the proximity of one cluster to another could be suggestive of the strength of existing working relationships between various job roles within a certain work process. For example, the marketing process involves target audience identification, the creation of a marketing strategy and its implementation and capturing customer value involving graphic/media designers, digital marketers, public relations managers, brand managers, social media specialists, sales account managers and software engineers for the development of marketplaces and customer relationship management systems (i.e clusters 22, 35, 36, 38, 68, 71, 72 76).

1.4.3 Revealed comparative advantage and average probability

One could assess the latent occupational construct of each cluster by making sense of a group of influential trigrams (i.e a sequence of three adjacent elements). A naive approach in ranking the importance of one trigram to another involves simply counting the number of times a trigram appears across all job advertisements, as seen in

Annex A. This results in a set of generic trigrams which may not be necessarily useful in detecting new and emerging occupations candidates but rather, is suggestive of the relative demand and popularity of the term.

Following Dawson et al.'s (2021) proposal, we find the Revealed Comparative Advantage (RCA) score for each trigram in every job advertisement within each cluster. This calculation down-weights trigrams that are common across all job advertisements per cluster. Then, for every unique trigram within each cluster, we find its average RCA (ARCA) score by taking a simple average across all job advertisements. We do this because trigrams may be repeated across job advertisements.

To consider the trigram's uniqueness across clusters, we calculate a global ngram score (GNS) by taking the natural logarithm of the total number of job advertisements divided by the number of times the trigram appeared across all clusters. We analysed 96,221 unique trigrams, excluding those that appeared in less than 3 distinct CJTs per cluster.

Next, we aggregated the ARCA, GNS and the average probability (AP)[94] sub-measures obtained from the occupation classification model in 1.3 into a composite index which we call the "New and Emerging Occupations Index" (NEOI), normalising each sub-measure by min-max scaling to lie within the range of 0 to 1. The NEOI for each trigram (TG) in a given cluster is defined as:

$$NEOI_{(TG,C_i)} = 0.5 * Norm.ARCA_{(TG,C_i)} * Norm.GNS_{TG} + 0.5 * (1 - AP)$$

where C_i refers to cluster i such that i $\in \{0, 1, 2, \ldots, 88\}$

where a high/low NEOI index suggests the relative importance in considering the corresponding job advertisement(s) as job postings with higher/lower likelihood of being identified as new and emerging occupation candidates. Similar weights were assigned to the outputs from both supervised and unsupervised approaches due to their equal importance.

To further narrow down the list of candidates, for each cluster, we extracted all the corresponding original job titles with the presence of the trigram, filtering for observations with NEOI greater than or equal to the 85-th percentile. Doing so limits our search to job titles that have a higher likelihood of being new or emerging occupations candidates. A total of 25,707 unique job titles (henceforth NEOI candidates) were surfaced for further processing.

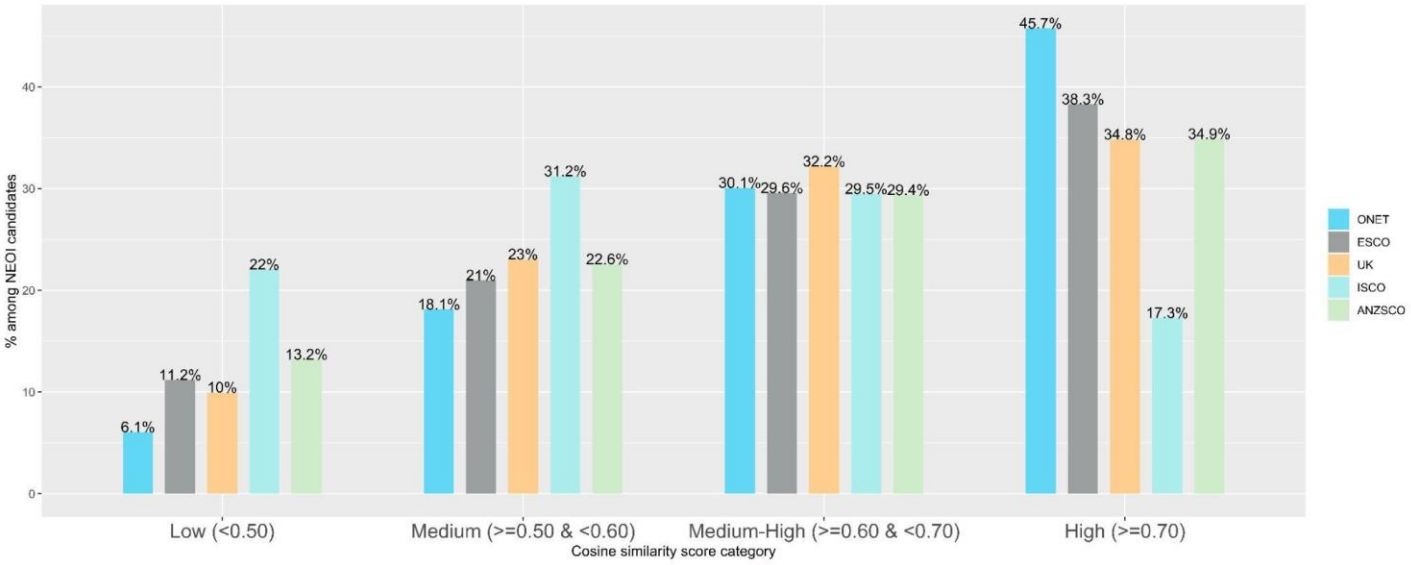
1.4.4 Cross-validation against established occupational classifications

We searched for the existence of the NEOI candidates in a selected number of recently updated National and Regional Occupational Classifications(NOCs/ROCs), relying on the use of the Occupational Information Network (O*NET; O*NET online, 27.3 database), European multilingual classification of skills, competences, qualifications and occupations (ESCO, version 1.1.1, 2022), UK Standard Classification of Occupations (UK SOC; Office for National Statistics, version 8, 2023), Australian and New Zealand Standard Classification of Occupations 2020 (ANZSCO; Statistics New Zealand, version 1.3.0, n.d.) and ISCO (ILO, 2012) using occupational groups titles and job title indexes[95]. For our purpose, it is important to use a variety of NOCs/ROC to ensure that the NEOI candidate is not country nor region specific and to check if the proposed candidate had already been identified in any NOC/ROC. We obtained the sentence embeddings of all NEOI candidates and titles using the universal sentence encoder deep averaging network encoding model (Cer et al., 2018), a variant of the transformer architecture of BERT described in **section 1.3**. Next, we compute the semantic textual similarity of a NEOI candidate against all titles using cosine similarity (CS). CS measures the cosine of the angle between two vectors projected in a multidimensional space. We partitioned the confidence of the matching process into 4 distinct groups; low, medium, medium-high and high, using the maximum CS score of the closest corresponding matching titles for each NOC/ROC.

[94] In deriving the average probability, we assume that the probabilities generalises across all ngrams per job advertisement.

[95] We are using titles in the rest of the paper, where this comprises the use of occupational group titles and/or job title indexes, synonyms or alternate titles.

Figure 3. Distribution of NEOI candidates by CS categories (Low, Medium, Medium-High, High), by NOC/ROC



Note: For each NOC/ROC, the titles are publicly available and require minimal preprocessing to enable its use. In descending order by number of unique titles, O*NET (44,545), ESCO (31,958), UK SOC (31,316), ANZSCO (8,731) and ISCO (7,011).

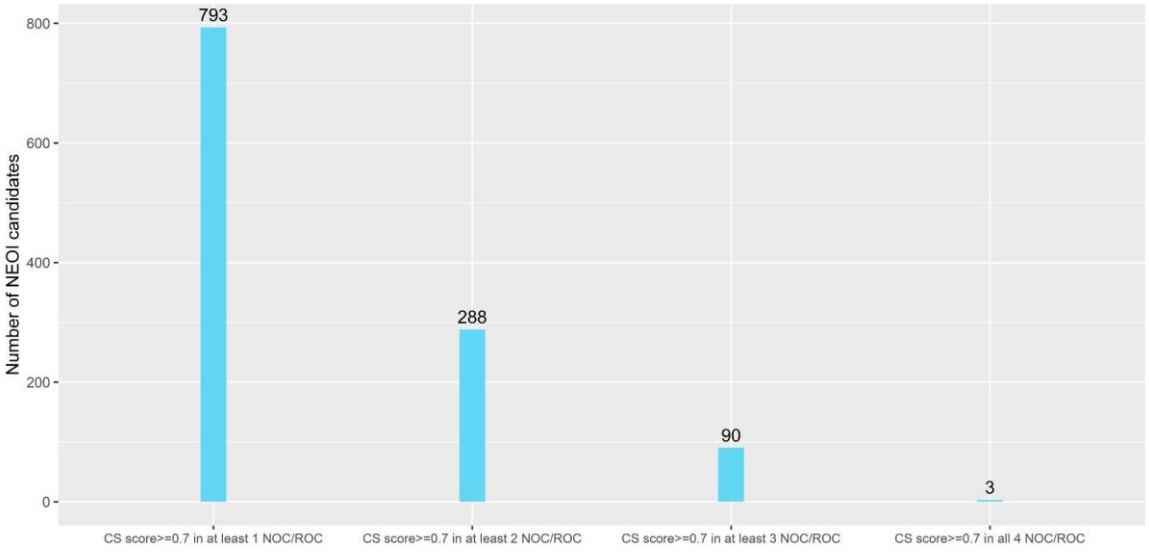
From **Figure 3**, with reference to the high CS category, the percentage of NEOI candidates being classified in this category is proportional to the number of titles, where a higher number of titles increases the probability of finding a title more closely matched to a NEOI candidate, with the exception of ANZSCO and ISCO titles. For ANZSCO, despite it being approximately 3.7 to 5.1 times smaller in size compared to the number of titles in O*NET, ESCO or UK SOC, the proportion of NEOI candidates being classified as being in the medium-high to high CS category is roughly similar. For ISCO however, the lower percentage of NEOI candidates classified as being in the high CS category as compared to other NOCs/ROC as well as the classification of more than 50% of candidates in the low to medium CS category lends further support that an update/revision is required. A comparison between the nomenclature used across each NOC/ROC is shown for a sample of NEOI candidates in **Table 2**.

Table 2. Examples of semantic textual similarity of NEOI candidates across all NOCs/ROC for Cluster 2 and 19

CS score(CSS)	NEOI candidate	ONET(CSS)	ESCO(CSS)	UK(CSS)	ISCO(CSS)	ANZSCO(CSS)
HIGH(CS score>=0.7)	Environmental asset engineer	Environmental engineer(0.824)	Environmental engineer(0.824)	Engineer, environmental(0.824)	Engineer, environmental(0.824)	Environmental engineer(0.824)
MEDIUM-HIGH(CS score>=0.6 & CS score<0.7)	Manager, land planning & environment	Land development manager(0.683)	Land acquisition manager(0.623)	Manager, environmental(0.640)	Consultant, land management environmental management(0.674)	Environmental manager(0.625)
MEDIUM(CS score>=0.5 & CS score<0.6)	Geospatial developer, land information	Geographic information system surveyor(0.520)	Cadastral land surveyor(0.560)	Surveyor, land(0.519)	Surveyor, land(0.519)	Land planner(0.517)
LOW(CS score<0.5)	Supply chain digital transformation lead	Supply chain development manager(0.482)	Senior supply chain planner(0.496)	Head of digital transformation(0.475)	Manager, supply chain(0.431)	Supply chain manager(0.397)

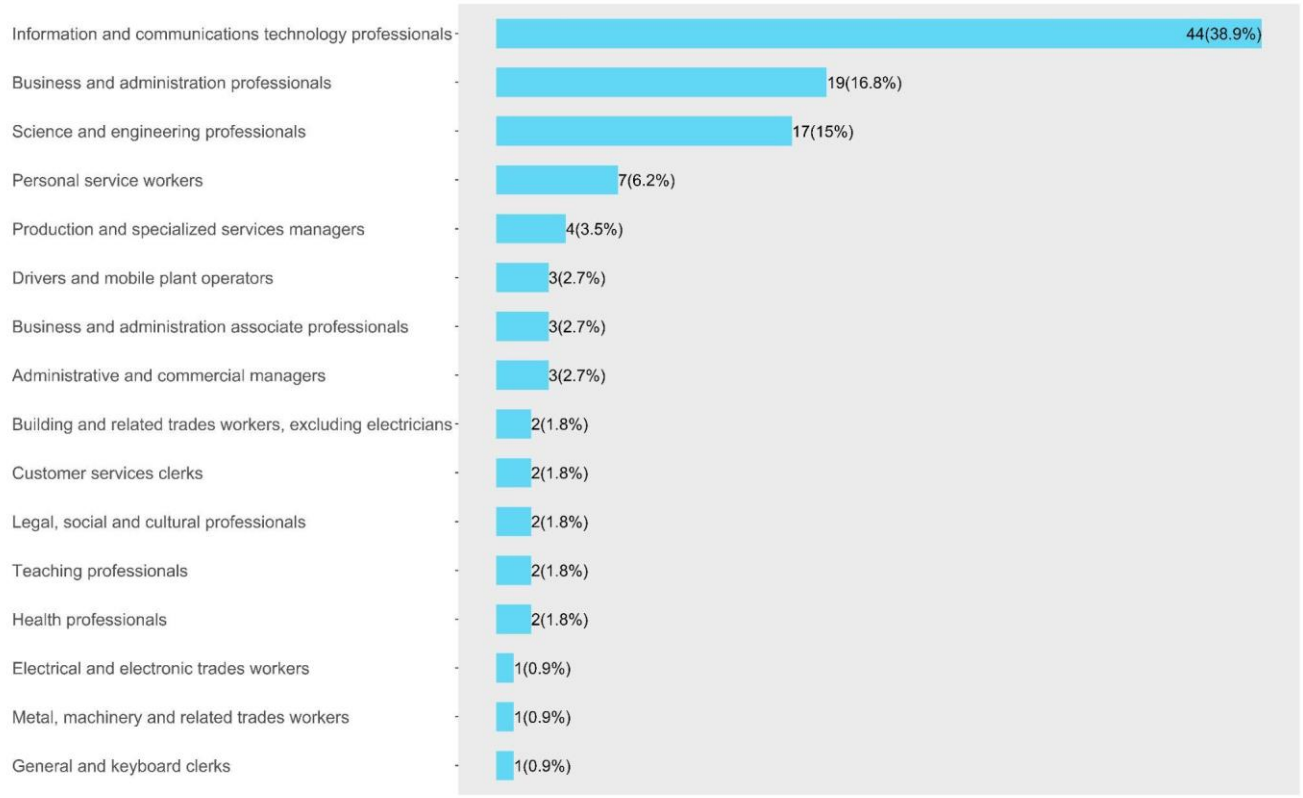
From Figure 4, our interest lies in the 5,655 (22%) NEOI candidates with a low CS score for ISCO, with a corresponding high CS score in at least 2 other NOC/ROC yielding a total of 288 candidates (henceforth RNEOI candidates, refer to **Annex B**).

Figure 4. Number of NEOI candidates by varying number of other NOC/ROC with a high CS score



To get a sense of the occupational distribution of the RNEOI candidates surfaced, we plot the ISCO 2-digit occupation distribution using the corresponding ISCO-08 code obtained from the most appropriate JTI match using ESCO[96]. ESCO was chosen over other NOCs as the classification maps to exactly one ISCO-08 unit group.

Figure 5. Occupation distribution of RNEOI candidates with CS score>=0.7 in ESCO



From **Figure 5**, 4 in 10 (38.9%) RNEOI candidates identified are ICT professionals, followed by business and administration professionals (16.8%) and science and engineering professionals (15%). The result is expected given the higher likelihood of such roles being advertised in OJAs by firms in the manufacturing and services sectors, such as finance or ICT (ILO, 2020). This is also consistent with the findings from the Future of Jobs Survey 2023 conducted by the World Economic Forum as presented in the Future of Jobs 2023 report (WEF, 2022) where the fastest growing roles are technology-related, increasing the likelihood of ICT jobs being advertised by businesses. **Table 3a** lists examples of RNEOI candidates along with the main tasks and duties performed.

[96] Among RNEOI candidates, the summary statistics of CS scores for ESCO (Min.=0.38,Median=0.6,Mean=0.61,Max=0.92).

Table 3a. Examples of RNEOI candidates with main tasks and duties

ISCO 2-digit description	RNEOI candidate	Main tasks and duties
Information and communications technology professionals	**Artificial intelligence product owner**	1. Define and communicate product vision and strategy, working closely with various stakeholders to understand market needs, identify opportunities and define the product route map. 2. Gathering and prioritising requirements from various stakeholders, maintaining and creating product-backlog. 3. Interpret customer requirements and define them with product functionality, translating them into technical language. 4. Managing cross-functional teams. 5. Collaborate with UI/UX designers to create a user-centric design for the AI product. 6. Adopts the use of Agile methodologies by defining user stories, acceptance criteria and sprint goals. 7. Develop and implement marketing plans, manage product budget and resources.
	Cloud network engineer	1. Design, plan, implement and maintain client-specific cloud solutions and cloud-based systems, including identifying appropriate cloud providers. 2. Work closely with stakeholders to ensure cloud resources are provisioned, managed and maintained in an efficient and secure manner. 3. Monitoring the utilisation, performance and availability of cloud network infrastructure and its services. 4. Migrating functions and networks to cloud infrastructure. 5. Network modelling, analysis and planning, including analysis of capacity needs for network infrastructure. 6. Design network and computer security measure, recommend network and data communications hardware and software.
	Cyber threat hunter	1. Active searching for potential security threats and vulnerabilities in an organisation’s systems and networks. 2. Analysing security data from various sources. 3. Investigating security incidents to determine root cause and identify vulnerabilities that may have been exploited. 4. Collaborate with other security professionals to identify, mitigate potential security threats and vulnerabilities.
Business and administration professionals	**Customer success advocate**	1. Building relationships with clients to improve client retention and sales growth. 2. Working with various departments to address the customer needs and concerns to ensure a seamless experience. 3. Monitor customer activity related to product or services and aid customers through onboarding, implementation and growth opportunities. 4. Reviewing customer journey, analyse campaign performance and use data to identify trends and areas for improvement.

	Scrum master	1. Facilitate the implementation of the Scrum framework and ensure that Scrum practices and principles are followed. 2. Coach and mentor the team on the Scrum theory and practices, Agile values and principles, as well as Scrum events and artefacts. 3. Ensuring scrum artefacts are up-to-date. 4. Working with stakeholders to remove any obstacles that are blocking progress and ensuring everyone is updated about the progress of the project. 5. Monitoring progress to ensure that the project is on track to meet its objectives. 6. Maintain visible product backlog, ensuring team progress is transparent to all stakeholders.
Science and engineering professionals	**User experience (UX) designer**	1. Creating satisfying and compelling experiences for users of a product, conducting or drawing on results from user research, interviews and surveys. 2. Understand user needs and create sitemaps, customer journey maps, user stories and personas. 3. Translate concepts into user flows, wireframes, mockups and prototypes. 4. Measure and optimise applications to improve usability and create the best user experience by exploring different approaches to solve end-user's problems, including user testing. 5. Collaborating with designers and developers to create intuitive, user-friendly software.

To ensure that the RNEOI candidates surfaced in **Table 3a** are not well matched to any unit groups in ISCO, we compared their main tasks and duties and obtained the corresponding CS score of the closest matched unit group. From **Table 3b**, all RNEOI candidates have a CS score of below 0.7, with Scrum master having the lowest CS score of 0.4 and Customer success advocates having the highest CS score of 0.66. Despite the CS score being greater than 0.6 for some candidates, comparing the main tasks and duties against the closest matched ISCO group highlights distinctively different roles. For example, an artificial intelligence product owner does not focus on the generation of visual content but rather the success of AI products. The findings further lend support to the urgent need to update/revise the existing ISCO classification structure to account for these occupations so as to derive meaningful and actionable labour market insights.

Table 3b. RNEOI candidate and the corresponding closest matched ISCO group

Closest matched ISCO 2-digit description	**RNEOI candidate**	**Closest matched ISCO 4-digit description (Code)**	**CS score**
Information and communications technology professionals	**Artificial intelligence product owner**	Graphic and multimedia designers (2166)	0.59
	Cloud network engineer	Computer network professionals (2523)	0.63
	Cyber threat hunter	Database and network professionals not elsewhere classified (2529)	0.52

Business and administration professionals	**Customer success advocate**	Technical and medical sales professionals, excluding ICT (2433)	0.66
	Scrum master	Sport coaches, instructors and officials (3422)	0.40
Science and engineering professionals	**User experience (UX) designer**	Graphic and multimedia designers (2166)	0.52

2 Benefits and limitations of approach

2.1 Data from online job postings

Data from online job postings is a double-edged sword because it has both advantages and disadvantages. The two main advantages of using online job postings data are its timeliness and granularity. As the data is near real-time, it avoids the time gaps associated with traditional data sources such as labour force surveys or establishment surveys which are typically conducted quarterly or annually. Data from online job postings also have a high degree of granularity made possible by leveraging on technological solutions such as natural language processing (NLP) models and interactive user interfaces to simplify or assist the user to navigate complicated occupation/skill taxonomies in the selection of their answers. Data from online job postings are not without limitations. The biggest drawback concerns the issue of representativeness where certain sectors and occupations are over/under-represented (ILO, 2020). For countries with a large share of informal economies, representativeness is highly questionable. Also, some job postings advertised in print media or through word of mouth would not be captured. The issue of representativeness could be observed through the lack of a cluster on agricultural, forestry and fishery occupations, with several clusters comprising ICT related occupations.

2.2 Lack of time series data

Our approach only considers a snapshot of the existing stock of job advertisements. As highlighted by the National Center for O*NET development (2006) in its methodology development report on “New and Emerging (N&E) Occupations”, as well as in the guiding principles of the NSC of Australia, it is important to also consider the growth of the new and emerging occupation candidate over time (e.g last 5 years) to ensure that the candidate is known and is growing in popularity.

2.3 Going beyond job titles

Job titles do not fully capture one's roles and responsibilities. To address the latter, data on one’s job tasks and description needs to be considered, summarised in a manner to retain key information that is succinct and comparable. The inclusion of the probabilities obtained from the occupation classification model in the NEOI seeks to achieve this but is far from perfect given the constraint on the sequence length at 512 tokens, potentially missing out information that could aid the prediction. Methods to circumvent this include truncating long sequences or aggregating classification results by breaking long sequences into smaller chunks.

3. Conclusion

This paper proposes an innovative approach to identifying new and emerging occupations using data from OJAs to facilitate the updating of ISCO-08. By leveraging OJA data, this method offers a more agile and up-to-date way of identifying new and emerging occupation candidates, keeping pace with the rapidly evolving job landscape. In the process, we introduced a novel composite index known as NEOI to estimate the likelihood of a job being a new and emerging occupation candidate. A higher NEOI score indicates that a job is more likely to be a new and emerging occupation. Cross-referencing candidates against recently updated NOCs (using semantic similarity) was critical in helping to narrow down our short list to a total of 288 candidates.

The findings suggest that our approach successfully identified potential new and emerging occupation candidates. However, additional refinements in the methodology approach is required and may include improvements to the training set used to train the classification model thereby leading to an improved F1 score, increasing the scope and coverage (i.e sectoral, occupation, geographical) of the data from online job advertisements to account for inherent biases, modifications to the text preprocessing steps including the use of a custom trained named-entity recogniser to remove irrelevant words/phrases as well as the consideration of alternative data sources for the validation of the candidates identified. The results additionally reinforce the urgent need for updating or revising the current ISCO classification framework to account for these new and emerging occupations, to enable meaningful and relevant labour market insights.

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Annex A

Cluster No.	Top 5 (Term, No. of occurence in cluster)
0	[('writing tutor jobs', 180), ('speaking tutor jobs', 180), ('vocabulary tutor jobs', 180), ('listening tutor jobs', 180), ('reading tutor jobs', 180)]
1	[('teacher tutor jobs', 9241), ('engineering teacher tutor', 381), ('reading teacher tutor', 363), ('yoga teacher tutor', 288), ('history teacher tutor', 201)]
2	[('supply chain management', 1339), ('supply chain manager', 442), ('manager supply chain', 410), ('supply chain analyst', 226), ('analyst supply chain', 215)]
3	[('babysitter needed children', 276), ('family day care', 259), ('babysitter needed child', 248), ('nanny needed child', 212), ('nanny needed children', 209)]
4	[('senior scrum master', 186), ('sap master data', 166), ('master data governance', 143), ('manager scrum master', 124), ('master data management', 100)]
5	[('senior salesforce developer', 259), ('salesforce marketing cloud', 206), ('salesforce commerce cloud', 120), ('apex visual force', 105), ('salesforce service cloud', 98)]
6	[('machine learning engineer', 671), ('business intelligence analyst', 368), ('business intelligence developer', 239), ('business intelligence engineer', 171), ('senior machine learning', 165)]
7	[('service desk analyst', 559), ('technology service desk', 291), ('information technology service', 286), ('information technology helpdesk', 175), ('service desk engineer', 157)]
8	[('senior procurement specialist', 63), ('assistant manager procurement', 45), ('senior procurement manager', 43), ('strategic sourcing manager', 43), ('procurement business partner', 42)]
9	[('user interface experience', 1625), ('user experience designer', 1558), ('user interface developer', 1361), ('interface experience designer', 1025), ('senior user experience', 790)]
10	[('senior property manager', 205), ('assistant property manager', 99), ('commercial property manager', 64), ('junior property manager', 55), ('claims service consultant', 54)]
11	[('accounts payable officer', 430), ('accounts receivable officer', 250), ('accounts payable specialist', 145), ('senior payroll officer', 137), ('accounts payable clerk', 99)]
12	[('human resource executive', 2132), ('human resource business', 1833), ('human resource manager', 1779), ('resource business partner', 1735), ('senior human resource', 1325)]
13	[('people culture business', 212), ('culture business partner', 212), ('learning development manager', 172), ('learning development specialist', 151), ('people culture advisor', 145)]
14	[('talent acquisition specialist', 1319), ('talent acquisition partner', 418), ('talent acquisition manager', 405), ('senior talent acquisition', 381), ('manager talent acquisition', 347)]
15	[('order management specialist', 63), ('management trainee rtr', 35), ('assistant manager order', 22), ('sales order management', 21), ('manager order cash', 21)]
16	[('senior category manager', 78), ('manager category management', 70), ('procurement category manager', 60), ('senior manager category', 58), ('category management sourcing', 38)]
17	[('supply chain planner', 108), ('sap materials management', 48), ('senior traffic engineer', 46), ('senior project planner', 44), ('senior transport planner', 38)]
18	[('software development engineer', 364), ('development engineer amazon', 135), ('software development manager', 110), ('development engineer alexa', 102), ('quality assurance engineer', 92)]
19	[('health safety advisor', 204), ('health safety environment', 126), ('work health safety', 123), ('health safety manager', 122), ('health safety officer', 116)]
20	[('associate graduate consultant', 62), ('graduate engineer trainee', 54), ('graduate software engineer', 48), ('graduate software developer', 39), ('trainee software engineer', 32)]

21	[('senior data scientist', 800), ('research development engineer', 364), ('clinical research associate', 244), ('lead data scientist', 239), ('manager data science', 145)]
22	[('ecommerce digital marketing', 43), ('digital marketing manager', 41), ('software engineer marketplace', 31), ('ecommerce marketing manager', 28), ('online marketing specialist', 27)]
23	[('chief financial officer', 624), ('chief executive officer', 557), ('chief operating officer', 258), ('chief technology officer', 209), ('executive assistant the', 149)]
24	[('senior internal auditor', 231), ('internal audit manager', 227), ('manager internal audit', 180), ('senior audit manager', 106), ('head internal audit', 94)]
25	[('senior tax accountant', 63), ('finance accounting tax', 52), ('corporate tax senior', 41), ('tax senior analyst', 41), ('tax compliance officer', 40)]
26	[('senior financial accountant', 479), ('group financial accountant', 124), ('senior management accountant', 107), ('business services accountant', 61), ('finance accounting manager', 61)]
27	[('teacher tutor jobs', 1458), ('state high school', 677), ('school teach queensland', 541), ('school crossing supervisor', 441), ('early childhood teacher', 429)]
28	[('senior product designer', 484), ('senior graphic designer', 453), ('senior copy writer', 243), ('software engineer tiktok', 215), ('junior graphic designer', 200)]
29	[('senior policy officer', 158), ('senior policy analyst', 45), ('senior policy advisor', 40), ('principal policy officer', 37), ('housing performance governance', 27)]
30	[('logistics customer care', 50), ('air freight import', 48), ('freight import coordinator', 38), ('sea logistics customer', 37), ('export sales manager', 35)]
31	[('senior legal counsel', 351), ('assistant company secretary', 63), ('senior manager legal', 59), ('senior associate special', 57), ('associate special counsel', 57)]
32	[('customer relationship management', 525), ('dynamics customer relationship', 398), ('microsoft dynamics customer', 212), ('enterprise resource planning', 202), ('dynamics enterprise resource', 185)]
33	[('user experience researcher', 298), ('medical laboratory scientist', 176), ('senior research fellow', 157), ('postdoctoral research fellow', 102), ('senior user experience', 97)]
35	[('marketing communications manager', 206), ('assistant brand manager', 148), ('senior brand manager', 143), ('marketing communications specialist', 115), ('marketing communications executive', 84)]
36	[('social media manager', 954), ('social media marketing', 697), ('social media executive', 266), ('social media specialist', 246), ('media marketing specialist', 215)]
37	[('logistics analyst job', 70), ('logistics customer service', 30), ('distribution centre manager', 29), ('logistics general manager', 23), ('customer service logistics', 21)]
38	[('customer relationship management', 1504), ('client relationship manager', 212), ('sap customer relationship', 161), ('customer relationship manager', 135), ('relationship management developer', 111)]
39	[('technology consulting national', 76), ('consultant technology consulting', 74), ('technology strategy transformation', 63), ('senior consultant technology', 60), ('manager digital transformation', 58)]
40	[('high reach forklift', 179), ('sales person required', 160), ('cabinet making apprentice', 126), ('field service fitter', 121), ('human resource truck', 117)]
41	[('mechanical design engineer', 428), ('field service technician', 407), ('senior electrical engineer', 364), ('senior mechanical engineer', 359), ('electrical design engineer', 193)]
42	[('senior civil engineer', 367), ('senior structural engineer', 330), ('civil structural engineer', 172), ('civil design engineer', 101), ('structural design engineer', 89)]
43	[('civil engineer roads', 37), ('senior bridge engineer', 29), ('senior architectural technician', 28), ('engineer roads highways', 25), ('structural engineer bridges', 24)]
44	[('group fitness instructor', 81), ('executive wellness coaches', 63), ('health wellness promoter', 51), ('learn swim instructors', 34), ('senior agile coach', 29)]

45	[('community engagement manager', 48), ('student support officer', 33), ('overseas education counsellor', 29), ('community engagement advisor', 28), ('head academic operations', 26)]
46	[('information technology support', 1275), ('information technology project', 1021), ('manager information technology', 728), ('technology project manager', 665), ('senior information technology', 664)]
47	[('senior network engineer', 522), ('cyber security engineer', 401), ('information security analyst', 254), ('network security engineer', 230), ('senior security engineer', 212)]
48	[('member technical staff', 1090), ('senior member technical', 588), ('embedded software engineer', 425), ('silicon design engineer', 340), ('physical design engineer', 252)]
49	[('desktop support engineer', 334), ('devops engineer docker', 76), ('information technology desktop', 69), ('desktop support technician', 68), ('linux system administrator', 67)]
50	[('risk compliance manager', 116), ('governance risk compliance', 88), ('financial reporting analyst', 84), ('operational risk manager', 79), ('senior manager risk', 74)]
51	[('disability support worker', 1044), ('district health board', 924), ('home care worker', 829), ('nurse unit manager', 802), ('community mental health', 614)]
52	[('senior financial analyst', 364), ('senior finance manager', 216), ('senior finance analyst', 203), ('assistant manager finance', 181), ('senior finance executive', 157)]
53	[('automation test engineer', 599), ('test automation engineer', 545), ('software test engineer', 500), ('senior test engineer', 389), ('software engineer test', 331)]
54	[('quality assurance engineer', 3492), ('senior quality assurance', 1368), ('quality assurance automation', 1257), ('software quality assurance', 990), ('assurance automation engineer', 810)]
55	[('customer service sales', 213), ('service sales housing', 212), ('manager business loans', 123), ('manager retail credit', 84), ('retail credit housing', 82)]
56	[('food beverage attendant', 653), ('guest service agent', 383), ('food beverage manager', 354), ('food beverage supervisor', 353), ('assistant restaurant manager', 333)]
57	[('big data developer', 398), ('big data engineer', 393), ('senior software engineer', 146), ('senior big data', 141), ('data warehouse developer', 106)]
58	[('assistant boutique manager', 43), ('fashion sales consultants', 41), ('visual merchandising manager', 34), ('country road visual', 28), ('instore visual merchandiser', 27)]
59	[('analyst team leader', 219), ('cib fund servicing', 109), ('cib trade lifecycle', 52), ('senior derivatives analyst', 50), ('cib payment lifecycle', 47)]
60	[('assistant vice president', 3555), ('senior vice president', 350), ('vice president senior', 329), ('vice president business', 240), ('vice president sales', 210)]
61	[('sap abap consultant', 249), ('sap abap development', 201), ('sap fico consultant', 199), ('sap basis consultant', 169), ('sap abap developer', 167)]
62	[('oracle database administrator', 531), ('sql database administrator', 333), ('senior database administrator', 213), ('sql server database', 109), ('server database administrator', 104)]
63	[('oracle apps technical', 91), ('oracle hcm cloud', 91), ('oracle fusion hcm', 61), ('techno functional consultant', 53), ('hcm functional consultant', 52)]
64	[('assistant store manager', 1443), ('casual sales assistant', 671), ('part time sales', 547), ('time sales assistant', 501), ('retail store manager', 417)]
65	[('retail team member', 732), ('team member warehouse', 539), ('time retail team', 292), ('part time retail', 219), ('casual retail team', 141)]
66	[('data entry operator', 369), ('part time full', 104), ('data entry clerk', 86), ('part time work', 79), ('data entry specialist', 55)]
67	[('performance marketing manager', 214), ('manager performance marketing', 77), ('performance marketing specialist', 68), ('senior performance engineer', 60), ('manager corporate strategy', 45)]

68	[('finance business partner', 574), ('senior account manager', 519), ('enterprise account executive', 353), ('senior account executive', 350), ('sales account manager', 327)]
69	[('specialist required carbatec', 343), ('carbatec call centre', 343), ('required carbatec call', 343), ('call centre brisbane', 343), ('technical specialist required', 343)]
70	[('sales admin executive', 90), ('sales support administrator', 87), ('administration support officer', 82), ('manager hired fast', 82), ('administrative support officer', 82)]
71	[('customer service officer', 1404), ('customer service executive', 828), ('customer service manager', 346), ('customer service associate', 310), ('customer service specialist', 306)]
72	[('customer service representative', 1716), ('sales development representative', 769), ('business development representative', 628), ('technical sales representative', 271), ('customer support representative', 185)]
73	[('senior systems engineer', 527), ('business systems analyst', 374), ('senior system engineer', 181), ('senior business systems', 126), ('business system analyst', 123)]
74	[('senior project manager', 1530), ('senior project engineer', 539), ('executive assistant manager', 110), ('senior operations manager', 106), ('senior executive assistant', 104)]
76	[('business development manager', 4812), ('business development executive', 2586), ('digital marketing manager', 1007), ('digital marketing executive', 984), ('digital marketing specialist', 925)]
77	[('technical support engineer', 878), ('technical project manager', 643), ('senior project officer', 238), ('technical support specialist', 216), ('senior technical support', 161)]
78	[('area sales manager', 896), ('agency development manager', 216), ('sales branch manager', 182), ('agency sales branch', 174), ('business development manager', 142)]
79	[('react native developer', 802), ('mobile application developer', 436), ('senior android developer', 343), ('senior software engineer', 285), ('mobile app developer', 273)]
80	[('senior solution architect', 269), ('senior cloud engineer', 223), ('cloud solution architect', 216), ('senior solutions architect', 194), ('cloud services software', 144)]
81	[('senior devops engineer', 1177), ('azure data engineer', 252), ('cloud devops engineer', 235), ('azure devops engineer', 193), ('aws data engineer', 135)]
82	[('full stack developer', 3751), ('java full stack', 1600), ('senior full stack', 1523), ('react javascript developer', 968), ('node javascript developer', 712)]
83	[('senior php developer', 631), ('php laravel developer', 180), ('php developer laravel', 107), ('php wordpress developer', 77), ('senior wordpress developer', 74)]
84	[('java developer spring', 431), ('developer spring boot', 278), ('java spring boot', 258), ('developer spring hibernate', 171), ('spring boot microservices', 154)]
85	[('senior frontend developer', 601), ('senior software engineer', 474), ('software engineer backend', 442), ('senior backend developer', 303), ('java backend developer', 298)]
86	[('senior software engineer', 6678), ('software development engineer', 1521), ('senior product manager', 963), ('lead software engineer', 917), ('specialist software engineering', 395)]
88	[('dot net developer', 1740), ('senior net developer', 540), ('asp net developer', 361), ('senior dot net', 280), ('net core developer', 209)]

Annex B

Cluster No.	RNEOI Candidates
2	demand supply planning expert, demand supply planning head, demand supply planning manager
4	agile coach scrum, scrum master, apmc scrum master, associate scrum master, digital scrum master, dynamics scrum master, fednow scrum master, guidewire scrum master, intermediate scrum master, kanban program scrum master, kanban scrum master, lead scrum master agile, lead scrum master agility, associate scrum master, ms dynamics scrum master, required scrum master, scrum master, scrum master active, scrum master adas systems, scrum master associate, scrum master digital, scrum master digital agile government, scrum master functional, scrum master functional engineer, scrum master iii, scrum master job, scrum master joiners, scrum master lead developer, scrum master nityo, scrum master pan, scrum master product, scrum master rpa, scrum master telecom, senior scrum contract, senior scrum master digital, senior scrum master, technical scrum master agile coach
5	salesforce technical architect service cloud lightning, senior salesforce cloud engineer, sfmc campaign manager
6	artificial intelligence machine learning lead, artificial intelligence ml architect, artificial intelligence operations, artificial intelligence product owner, artificial intelligence resident deep learning, artificial intelligence resident material informatics, artificial intelligence solutions lead, associate machine learning, chatbot artificial intelligence, head artificial intelligence, head artificial intelligence machine learning, lecturer artificial intelligence
7	associate foreign language, onsite corporate recruiter
9	fresher user experience designer, game user experience lead designer, head user experience design, intermediate user experience designer, java user interface architect, lead user experience interface engineer, pega user interface, user interface rement developer metlife, senior designer visual user experience print, senior lead user interface developers, senior user experience architect devgraph, senior user experience content designer, senior user experience designer remote, specialist user experience interface, user experience designer iii, user experience designer remote, user experience designers imu, user experience lead client, user interface artist, user interface designer, user interface developer, user interface fullstack, user interface leads, user interface path lead engineer, user interface visual designer app, user interface visual designer b2b
12	human resource recruiter, human resource recruiter work home
13	risk manager operating effectiveness assurance
14	graduate talent acquisition ordinator, lead talent management, talent acquisition adviser, talent acquisition coordinator, talent acquisition research lead, talent acquisition specialist, talent sourcing executive
16	category management associate, procurement category support
24	external quality auditor
27	access services educator, social science teacher class cbse
28	3d artists production house, content manager videos, digital strategist content curator, intermediate digital designer, learning instructional designer lead, opening content writer, opening content writer
30	export documentation officer
31	client rights advocate, customer success advocate, family law project staff attorney, youth advocate streetwork
32	blucognition sharepoint developer spfx powerapps, infosys junior sharepoint developer spfx nintex, infosys

	sharepoint developer lead spfx csom, intermediate sharepoint developer, mid sharepoint developer, office sharepoint online developer, senior lead sharepoint developer, senior sharepoint architect, sharepoint developer lead architect, sharepoint developer lead net sql, sharepoint developer nintex spfx, sharepoint developer spfx, sharepoint developer spfx nintex, sharepoint o365 developer analyst, sharepoint o365 developer lead, sharepoint online developer migration expert, sse lead sharepoint developer
34	java developer, scrum master
35	external communications lead
36	b2b campaign manager, senior campaign manager contract, technology strategist anz, technology strategist digitas
40	casual general labourer, ceiling fixers, parts storeperson, sheet metal tradesperson
43	bim modeller autocad consultant
45	lso community engagement
46	product information assistant
47	cloud infrastructure security engineer, cloud network engineering, cloud network implementation services engineer, cloud network services, cloud networking lead, cloud security lead, cyber threat hunter, embedded security penetration tester, penetration test lead, senior application penetration tester
48	analog digital ic designer, embedded developer rtos python, embedded python developer, embedded software integrator, lead verification validation engineer, senior validation verification engineer, test validation engineer senior, validation emulation engineer, validation verification engineer
49	blockchain l3 support engineer, python developer kubernetes
50	lead operation risk management, risk management compliance, risk management coordinator content, risk management support, senior manager operational risk advisory, senior quality compliance specialist
51	case management lead, gp locum position, senior physiotherapist based full
53	automation data test lead, automation tosca tester oc01, bilingual automation testing, test automation strategy, tosca automation testing
54	agm quality assurance, digital data quality officer
55	java developer loans, manager fraud risk lodha
56	asstmgr front office, casual grill cooks, cocktail server marquee, crown waitperson, demi chef banquets, experienced waiting staff, senior south indian chef, wait staff hosts
57	bigdata hadoop spark developer, hadoop developer, hadoop developer admin support, hadoop developer admin support, hadoop developer edmp, hadoop developer hive unix, hadoop scala developer, java developer scala, joiners hadoop admin, sql etl developer
59	reconciliation officer
60	c10 java developer, developer java c12, developer java j2ee c10, developer java j2ee c11, developer java j2ee cdo c10, developer java officer c10, java developer c11 cts, java developer citirisk c11, java senior developer c11, senior developer java j2ee c12, senior java developer c11, vice president operation
63	java developer hrms
65	bushland team member, crew member dt, crew member south, overnightfill team member, sa crew member, team member big, team member level, team member position, wests team member
66	entry level fundraising, python developer entry level

68	client services lead
69	java developer fresher, junior java developer fresher
71	customer experience lead, lead customer experience
72	consumer service representative
75	det blockchain fullstack manager
79	android ios developers, android senior developer, java android developer, senior android developers, senior java android developer
80	cloud infrastructure lead, cloud product specialist
81	azure cloud lead engineer, team lead devops
82	java angular senior developer, java ext javascript developer, java full stack developer, java node javascript developer
84	devops engineer microservices architecture, java boot developer, java developer j2ee boot api, java developer remote, java developers, java j2ee cloud developer, java j2ee support, java micro service developer, java microservice developer boot, java springboot developer, senior java springboot developer
85	backend python developer, golang java developer, java backend developers senior, python cloud developer, python developer, python lead developer
86	product support associate
87	java developer, java developers senior, java developers senior lead, junior java developers, python developer information technology
88	net developer ado

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