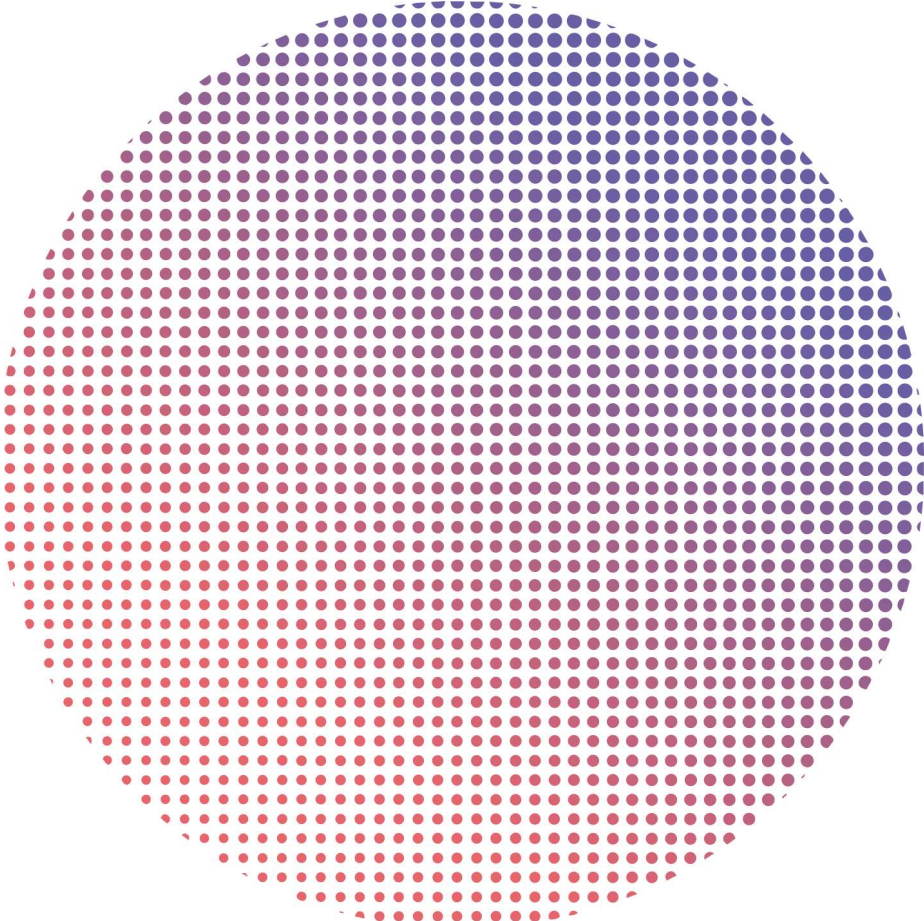# Effective Professional Development Design in a Civil Service Context – Protocol for a systematic review

**Prepared for Government Skills**

alma economics

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# Introduction

## Review rationale

Globally, the public sector is a major employer accounting for 17% of total employment and 38% of formal employment, according to the Worldwide Bureaucracy Indicators (World Bank, 2023). As of March 2024, the UK civil service employs around 540,000 people in various departments, agencies, and professions, playing a key role in shaping employment practices, policies, and standards throughout the broader public sector workforce (Civil Service Statistics, 2024).

The public sector is also an important employer of high-skilled labour (World Bank, 2023). Within the context of more people opting out of the workforce or being unable to work, as well as a mismatch between previously required skills and those required in the future, it is understood that training and development programmes must be effective and well-targeted (Frontier Economics, 2022). Additionally, there are productivity challenges faced by the UK economy and public sector, often linked to chronic underinvestment, including in training and development of skills (e.g., ONS, 2023; Van Reenen and Yang, 2024; The Productivity Institute, 2022 & 2024). Enhanced productivity is anticipated to lead to improved service delivery and increased social welfare indicators at the same level of expenditure—in other words, more efficient and impactful public spending (Romani, 2021).

In light of the skills and productivity landscape within the UK's public sector, it is important to work towards an understanding of how and under what conditions investment in skills development can be a driver of public sector organisational performance, delivery, efficiency, and productivity. Given the influence of the civil service on the wider public sector, this investment is likely to have an influence on the wider economy and society.

Currently, a considerable amount is spent yearly by the UK civil service on professional development and learning activities. Previous systematic reviews in the professional development area (e.g., Filges et al., 2019; Sims et al., 2021) define professional development as facilitated learning opportunities for qualified professionals that aim to enhance the professionals' knowledge and skills in ways that are relevant for application in practice, that is, to serve ultimate beneficiaries. Kahmann, Droop and Lazonder (2022) found that outcomes of professional development for teachers were centred around staying up to date with professional knowledge and skills as well as reflecting on practices, values, and personal goals.

In order for the UK civil service to ensure its investments in professional development are most effective, there needs to be extensive and high-quality evidence synthesis work to support future decision making. To understand quality of the current evidence base, we undertook an initial overview of literature as well as scoping interviews with relevant professionals. The current evidence base consists mostly of work carried out on the design features and mechanisms of effective professional development in other public sectors, as can be seen within comprehensive guides for the teaching and medical professions (e.g., EEF, 2021 and AMEE Guides).

Filges et al (2019) conducted a systematic review on the effectiveness of continuing professional development for welfare professionals (i.e., those working within education, social welfare, and crime and justice). No eligible studies were identified for social welfare or crime and justice, with all 51 eligible studies relating to education. However, even within the education-related literature there are limitations. Sims and Fletcher-Wood (2020) carried out a critical review of reviews identifying characteristics of effective teacher professional development and found the evidence base to employ at times unsuitable inclusion criteria and depend on less robust inference methods. Research into effective professional development in the education sector has also identified a number of concerns,

including high workloads and competing priorities of learners, a lack of funding for programmes, and a lack of belief in the efficacy of programmes (Adams et al., 2023).

Similar work to the evidence reviews described above has not been conducted in the context of the civil service. The current evidence base related to the civil service is also of variable quality, fragmented, and from a range of international contexts (Elliot, Bottom, and O'Connor, 2023). This has been a long-standing issue within this field of research with Chapman (1983) identifying a lack of a unified framework of concepts within public administration teaching as well as academics and practitioners 'drifting apart'.

Therefore, Government Skills has commissioned three projects within an integrated programme of evidence synthesis and evaluation to develop high-quality and actionable evidence on the links between effective learning and development interventions, workforce skills, and productivity. As part of this, the current systematic review will synthesise the evidence on the design features (such as duration or mode of delivery) and mechanisms of professional development that are associated with effective development of productivity-enhancing skills within a civil service context.

This review will employ a systematic search of the literature exploring effective professional development design. Importantly, information regarding the 'mechanisms' of interventions will also be gathered to inform the creation of a taxonomy of effective mechanisms of professional development design. Mechanisms are 'active ingredients' which would make an intervention less effective if they were to be removed (Sims et al., 2021). Meta-analysis (if determined possible) will then be carried out. The systematic evidence review will inform the creation of evidence-based tools and recommendations for future investment into professional development within the UK civil service. In practice, these tools and recommendations can be utilised to improve professional development interventions, both within and outside of the civil service. The insights generated can be used by a range of audiences, including practitioners, researchers, and learners. These improvements can also go some way in addressing concerns (e.g., Adams et al., 2023) and lead to prioritisation of professional development across a number of professions.

# Objectives

The objective of this review is to synthesise existing high quality literature to identify the characteristics of effective professional development in a civil service context and adjacent contexts. It will explore the overall effectiveness of these interventions in driving improvements in knowledge, skills, networks, work performance and productivity, examine the mechanisms, design features and forms (clusters of mechanisms) of professional development associated with the greatest impact on driving these improvements, and identify factors that support the successful implementation of professional development programmes in the civil service context and adjacent contexts.

To achieve this, we will address four research questions:

1) What are the characteristics of the studies and interventions in the experimental impact evaluation literature on professional development design in the civil service context and adjacent contexts?

2) Overall, how effective are professional development interventions in the civil service context at improving knowledge, skills, networks, work performance and productivity?

   a) Does this vary based on study characteristics (features of the evaluation not specific to the intervention itself)?

   b) Does effectiveness of the interventions vary based on types of worker, target outcome, or form of professional development?

3) Which design features and forms of professional development are associated with the greatest

impact?

    a) Which design features (e.g., online versus face to face; longer duration versus shorter duration), are associated in the literature with greatest impact on skills, knowledge, networks, work performance and productivity?

    b) Which forms (clusters of mechanisms) do we observe in the literature?

    c) Are forms more likely to be effective when they incorporate particular combinations of mechanisms?

    d) Which forms (clusters of mechanisms) are associated with the largest effects on participant skills, knowledge, networks, work performance and productivity?

4) What supports successful implementation of professional development interventions targeted at driving improvements in skills, knowledge, networks, work performance and productivity in the civil service context and adjacent contexts?

# Methodology

## Eligibility criteria

The eligibility criteria are built around the PICO framework, which is one of the most appropriate models for structuring intervention-based research questions for systematic reviews and helps to define the project's scope precisely. To be included in the review, studies will need to meet all of the following inclusion and exclusion criteria. Please note that the documentation and implementation of the screening process (including the order of screening) is described in the *'Study Selection'* section of this protocol.

- **Population**: Studies involving workers employed by the civil service are central to our analysis and will be included. However, our scoping searches have revealed a lack of high-quality evidence when including solely the international civil service workforce. Hence, we have decided to broaden the scope of the analysis while ensuring the evidence remains relevant to the civil service. To do so, we will include studies that target workers operating in UK civil service professions across the civil service, the wider public sector and the private sector. This approach is based on the assumption that interventions targeting these professions in other settings (such as the wider public sector and the private sector) will still focus on outcomes that are relevant to those same professions in the civil service context. We will focus on the five civil service professions that employ the most workers in the civil service and cover more than 75% of the civil service workforce in the UK: 1) Operational Delivery, 2) Policy, 3) Digital, Data & Technology, 4) Project Delivery and 5) Tax. Interventions targeting people in the wider public and private sector that are not part of these five professions will be excluded to ensure the feasibility of the systematic review within the allocated time and budget (e.g. teachers, medical staff, police, human resource professionals etc.).

- **Intervention**: Building on previous professional development design systematic reviews (e.g. Filges et al., 2019, Sims et al., 2021) and for the purposes of this review, professional development is understood as the deliberate process of acquiring and driving knowledge, skills, networks, work performance and productivity for professionals. Hence, this review focuses on interventions aimed at enhancing professionals' knowledge, skills, and networks, or interventions targeting improvements in work performance and productivity. Studies that have interventions that are deliberate processes of enhancing professionals' knowledge, skills, networks, work performance or productivity will be included. Studies that do not involve any interventions related to professional development or that focus on interventions unrelated to knowledge, skills, networks, or work performance improvements will be excluded.

- **Comparator**: The comparator includes alternative forms of a professional development intervention (e.g., a limited form of the intervention), no professional development intervention or a pre-intervention period (for e.g. Interrupted Time Series (ITS) studies). Studies that do not have a comparator (such as alternative intervention, no intervention, or pre-intervention period) will be excluded.

- **Outcomes**: Studies must contain a quantitative outcome measure for (or proxies for) changes in skills, knowledge, networks, work performance or productivity. Studies focusing on other outcomes (e.g., job satisfaction, well-being, organisational culture, job retention) or without a quantitative outcome measure will be excluded. We intend to use the following definitions of the outcome variables:
  - **Knowledge**: Knowledge is a familiarity, awareness, or understanding of someone or

something, such as facts, information, or descriptions, which is acquired through experience or education, by perceiving, discovering or learning. Knowledge can refer to a theoretical or practical understanding of a subject. (Adapted to context from Librarianship Studies & Information Technology, 2017)

- o **Skills**: The ability to apply knowledge and use know-how to complete tasks and solve problems. (CEDEFOP, 2014)

- o **Networks**: Interpersonal relationships that connect individuals or organisations, facilitating the exchange of ideas and resources to achieve specific goals. They encompass both informal sources, such as personal contacts, and formal structures, like organisational connections, contributing to collaboration and information sharing within professional development contexts. (Adapted to context from Saltiel, 2006)

- o **Work performance**: Work performance encompasses not only task proficiency but also adaptive and proactive behaviours that enable individuals to respond to dynamic changes and take initiative in improving processes or outcomes. (Adapted from López-Cabarcos, Vázquez-Rodríguez, & Quiñoá-Piñeiro, 2022)

- o **Productivity**: Productivity refers to the efficiency and effectiveness with which inputs (skills, knowledge, resources) are converted into improved outputs such as service delivery and societal outcomes. This encompasses both technical efficiency (performing current tasks better) and allocative efficiency (ensuring the right activities are pursued to maximise impact). (Adapted from Aldridge, Hawkins, & Xuereb, 2016)

- **Geographical focus**: To ensure the relevance of findings to the UK civil service, this review will include studies from OECD member countries only. OECD member countries have comparable economic and administrative structures to the UK, making their findings more applicable and relevant for the UK context than non-OECD countries. Studies from non-OECD countries will be excluded to maintain high contextual relevance and comparability.

- **Methodology**: Studies using randomised control trials (RCTs) or quasi-experimental research designs will be included. To ensure we capture a sufficient amount of evidence while obtaining valuable insights into the effectiveness of interventions, we will include all types of quasi-experimental designs, including single-group pre-test/post-test studies. All other research designs will be excluded.

- **Date of publication**: To ensure the relevance of our findings to contemporary civil service practices, we will include studies published from 1 January 2004 to 1 September 2024. This 20-year period captures significant public sector reforms and the rapid digital transformation that have reshaped professional development within the civil service. The early 2000s marked the start of major initiatives like the Modernising Government agenda and the Gershon Review (2004), which emphasised efficiency, accountability, and the adoption of digital technologies (also Dunleavy et al., 2006). These changes necessitated new skills and continuous learning for civil servants, making this period crucial for understanding current professional development trends.

- **Language of publication**: We will include only studies written in English. By concentrating on English-language publications, we aim to maintain a manageable scope for the review while ensuring that the evidence is accessible and understandable to the intended audience. Studies published in other languages will be excluded to streamline the review process and adhere to the project's time and budget constraints.

- **Types of publication**: We will include journal articles, working papers, research reports, theses and dissertations and exclude book chapters.

# Information sources

Our objective is to retrieve evidence from academic databases, grey literature repositories, through a call for evidence and through snowballing of relevant papers. We will record the information source each study was retrieved from, and we will apply the inclusion/exclusion criteria to all of them. We will use the following data sources to search for evidence:

- **Academic bibliographic databases:** Education Resources Information Center (ERIC), IDEAS/RePEc, Web of Science, Scopus.

- **Grey literature repositories:** gov.uk (Type filters: 'Research and statistics' and 'Policy Papers and Consultations' only), OECD ilibrary (Content type filter: Journals, Articles and Papers), ProQuest (Source type filter: 'Government & Official Publications', 'Reports', 'Scholarly Journals', 'Dissertations & Theses' and 'Working Papers' only), World Bank Open Knowledge Repository, Campbell Collaboration, Cedefop (Content type filter: Publications only), GoogleScholar (limited to first fifty results only)[1]

- **Additional ways of adding papers.** In addition to the public databases, we are collecting research and studies from the following sources:

    o **Call for evidence and stakeholder engagement**: We have issued a public call for evidence to address potential publication bias. Alongside this, we have conducted interviews with key stakeholders, requesting any relevant materials they may have.

    o **Snowballing**: We are using snowballing techniques to expand our evidence base, including both backward and forward citation tracking. This involves reviewing the reference lists of studies included in the systematic review through the other sources to identify additional relevant papers, as well as examining studies that have cited the included papers. We will implement this process using the online tool SpiderCite, with documentation of the source.

# Search strategy

Table 1 below presents a list of keywords reflecting the research objectives that will be used to identify relevant sources of evidence. During the scoping phase, we tested different combinations of keywords to arrive at this list. Based on these documented searches some keywords were dropped (e.g. education) when they did not add to more relevant results.

These keywords will be combined into search strings, using Boolean operators (AND/OR/NEAR) and other database-specific search operators, to arrive at a long list of materials, which will then be screened to see if they meet the inclusion criteria set out in the next section. Given that each database has different settings and possibilities and to ensure the search process is transparent, we will record all search strings and filters used across the different databases, as well as outcomes from our searches (that is, dates and numbers of retrieved items) in a Research Activity Sheet.

The search strings are presented below in Table 1, and an example database search can be found in Appendix A. The three keyword groups will be combined with AND operators.

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[1] The Cochrane Handbook highlights that limiting search results from search engines that produce more entries than can be feasibly screened is a sensible approach, particularly given the often low precision of these searches. Furthermore, as replicability tends to be more challenging with search engines compared to bibliographic databases, we will export and document the first 50 entries and use privacy mode in our browser to ensure we minimise the influence of personal recommendations or algorithms on the search results. (Lefebvre et al., 2023)

**Table 1.  Keyword groups and search strings**

| **Keyword group 1 – Population**<br><br>Searched for in title, abstract and indexing terms/keywords (where available) | **General civil service:**<br><br>"civil service" OR "civil servant" OR "civil servants" OR "public sector" OR "public administration" OR "public administrators" OR "public management" OR "government employee" OR "government employees" OR "government worker" OR "government workers" OR "government workforce" OR "government work force" OR "government staff" OR "government personnel" OR "government agency" OR "government agencies" OR "government official" OR "government officials" OR "government department" OR "government departments" OR "public employee" OR "public employees" OR "public worker" OR "public workers" OR "public workforce" OR "public work force" OR "public staff" OR "public personnel" OR "public manager" OR "public managers" OR "public official" OR "public officials" OR "public service employee" OR "public service employees" OR "public service worker" OR "public service workers" OR "public service workforce" OR "public service work force" OR "public service staff" OR "public service personnel" OR "public service manager" OR "public service managers" OR "public service official" OR "public service officials" OR "public servant" OR "public servants" OR "federal employee" OR "federal employees" OR "federal worker" OR "federal workers" OR "federal workforce" OR "federal work force" OR "federal staff" OR "federal personnel" OR "federal agency" OR "federal agencies" OR "federal official" OR "federal officials" OR "state employee" OR "state employees" OR "state worker" OR "state workers" OR "state workforce" OR "state work force" OR "state staff" OR "state personnel" OR "state agency" OR "state agencies" OR "state official" OR "state officials" OR "local government" OR "local governments" OR "local official" OR "local officials" OR "local authority" OR "local authorities" OR "municipal government" OR "municipal governments" OR "municipal employee" OR "municipal employees" OR "municipal worker" OR "municipal workers" OR "municipal workforce" OR "municipal work force" OR "municipal staff" OR "municipal personnel" OR "municipal official" OR "municipal officials" OR "regional government" OR "regional governments" OR "regional employee" OR "regional employees" OR "regional worker" OR "regional workers" OR "regional workforce" OR "regional work force" OR "regional staff" OR "regional personnel" OR "regional official" OR "regional officials" OR<br><br>**Operational delivery (Largest Civil Service Profession):**<br><br>"operational employee" OR "operational employees" OR "operational worker" OR "operational workers" OR "operational workforce" OR "operational work force" OR "operational staff" OR "operational manager" OR "operational managers" OR "government front office" OR "government back office" OR "public service operations" OR "government operations" OR "court employee" OR "court employees" OR "court worker" OR "court workers" OR "court work |
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force" OR "court workforce" OR "court staff" OR "prison employee" OR "prison employees" OR "prison worker" OR "prison workers" OR "prison workforce" OR "prison work force" OR "prison officer" OR "prison officers" OR "prison staff" OR "prison manager" OR "prison managers" OR "tribunal officer" OR "tribunal clerk" OR "court service officer" OR "border force officer" OR "border force officers" OR "immigration officer" OR "immigration officers" OR "customs officer" OR "customs officers" OR "probation officer" OR "probation officers" OR "civil enforcement officer" OR "public service bailiff" OR "enforcement officer" OR "passport control officer" OR "passport control officers" OR "visa processing officer" OR "visa processing officers" OR "consular employee" OR "consular employees" OR "consular worker" OR "consular workers" OR "consular workforce" OR "consular work force" OR "consular officer" OR "consular officers" OR "consular staff" OR "consular manager" OR "consular managers" OR "job centre employee" OR "job centre employees" OR "job centre worker" OR "job centre workers" OR "job centre workforce" OR "job centre work force" OR "job centre staff" OR "job centre manager" OR "job centre managers" OR "job center employee" OR "job center employees" OR "job center worker" OR "job center workers" OR "job center workforce" OR "job center work force" OR "job center staff" OR "job center manager" OR "job center managers" OR "work coach" OR "work coaches" OR "call centre employee" OR "call centre employees" OR "call centre worker" OR "call centre workers" OR "call centre workforce" OR "call centre work force" OR "call centre staff" OR "call centre manager" OR "call centre managers" OR "call center employee" OR "call center employees" OR "call center worker" OR "call center workers" OR "call center workforce" OR "call center work force" OR "call center staff" OR "call center manager" OR "call center managers" OR "employment advisor" OR "employment advisors" OR "customer service employee" OR "customer service employees" OR "customer service worker" OR "customer service workers" OR "customer service workforce" OR "customer service work force" OR "customer service staff" OR "customer service representative" OR "customer service representatives" OR "customer service advisor" OR "customer service advisors" OR

**Policy (2ⁿᵈ largest Civil Service Profession):**

"policy advisor" OR "policy advisors" OR "policy staff" OR "policy officer" OR "policy officers" OR "policy adviser" OR "policy advisers" OR "policy design" OR "policy designing" OR "policy delivery" OR "policy advice" OR "policy briefing" OR "policy implementation" OR "policy implementing" OR "policy evaluation" OR "policy evaluations" OR "policy evaluating" OR "policy official" OR "policy delivering" OR "policy advising" OR "policy research" OR "policy consultation" OR "policy legislation" OR "strategy design" OR "strategy designing" OR "strategy delivery" OR "strategy advisor" OR "strategy advisors" OR "strategy advice" OR "strategy briefing" OR "strategy

implementation" OR "strategy implementing" OR "strategy evaluation" OR "strategy evaluations" OR "strategy evaluating" OR "strategy designing" OR "strategy advising" OR

**Digital, Data & Technology (3rd largest Civil Service Profession):**

"business architect" OR "business architects" OR "data architect" OR "data architects" OR "enterprise architect" OR "enterprise architects" OR "network architect" OR "network architects" OR "security architect" OR "security architects" OR "solution architect" OR "solution architects" OR "technical architect" OR "technical architects" OR "analytics engineer" OR "analytics engineers" OR "data analyst" OR "data analysts" OR "data engineer" OR "data engineers" OR "data ethicist" OR "data ethicists" OR "data governance manager" OR "data governance managers" OR "data scientist" OR "data scientists" OR "machine learning engineer" OR "machine learning engineers" OR "performance analyst" OR "performance analysts" OR "application operations engineer" OR "application operations engineers" OR "business relationship manager" OR "business relationship managers" OR "change and release manager" OR "change and release managers" OR "command and control centre manager" OR "command and control centre managers" OR "end user computing engineer" OR "end user computing engineers" OR "it service manager" OR "it service managers" OR "incident manager" OR "incident managers" OR "infrastructure engineer" OR "infrastructure engineers" OR "infrastructure operations engineer" OR "infrastructure operations engineers" OR "problem manager" OR "problem managers" OR "service desk manager" OR "service desk managers" OR "service transition manager" OR "service transition managers" OR "business analyst" OR "business analysts" OR "delivery manager" OR "delivery managers" OR "digital portfolio manager" OR "digital portfolio managers" OR "product manager" OR "product managers" OR "programme delivery manager" OR "programme delivery managers" OR "program delivery manager" OR "program delivery managers" OR "service owner" OR "service owners" OR "quality assurance testing analyst" OR "quality assurance testing analysts" OR "qat analyst" OR "qat analysts" OR "test engineer" OR "test engineers" OR "test manager" OR "test managers" OR "development operations engineer" OR "development operations engineers" OR "devops engineer" OR "devops engineers" OR "frontend developer" OR "frontend developers" OR "software developer" OR "software developers" OR "accessibility specialist" OR "accessibility specialists" OR "content designer" OR "content designers" OR "content strategist" OR "content strategists" OR "graphic designer" OR "graphic designers" OR "interaction designer" OR "interaction designers" OR "service designer" OR "service designers" OR "technical writer" OR "technical writers" OR "user researcher" OR "user researchers" OR

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| | **Project delivery (4th largest Civil Service Profession):**<br><br>"project delivery" OR "project manager" OR "project managers" OR "project management" OR "project lead" OR "project leader" OR "project leaders" OR "project leadership" OR "project admin" OR "project administration" OR "project administrator" OR "project planning" OR "project analyst" OR "project support" OR "project consultant" OR "project consultants" OR "project consultancy" OR "project consultation" OR "project coordination" OR "project coordinator" OR "project coordinators" OR "project director" OR "project directors" OR "programme delivery" OR "programme manager" OR "programme managers" OR "programme management" OR "programme lead" OR "programme leader" OR "programme leaders" OR "programme leadership" OR "programme admin" OR "programme administration" OR "programme administrator" OR "programme planning" OR "programme analyst" OR "programme support" OR "program delivery" OR "program manager" OR "program managers" OR "program management" OR "program lead" OR "program leader" OR "program leaders" OR "program leadership" OR "program admin" OR "program administration" OR "program administrator" OR "program planning" OR "program analyst" OR "program support" OR "resource delivery" OR "resource manager" OR "resource managers" OR "resource management" OR "resource lead" OR "resource leader" OR "resource leaders" OR "resource leadership" OR "resource admin" OR "resource administration" OR "resource administrator" OR "resource planning" OR "resource analyst" OR "resource support" OR "business case delivery" OR "business case manager" OR "business case managers" OR "business case management" OR "business case lead" OR "business case leader" OR "business case leaders" OR "business case leadership" OR "business case admin" OR "business case administration" OR "business case administrator" OR "business case planning" OR "business case analyst" OR "business case support" OR<br><br>**Tax (5th largest Civil Service Profession):**<br><br>"tax professional" OR "tax professionals" OR "tax specialist" OR "tax specialists" OR "tax lead" OR "taxation professional" OR "taxation professionals" OR "taxation specialist" OR "taxation specialists" OR "taxation lead" OR "tax centre" OR "tax centres" OR "tax center" OR "tax centers" OR "tax agency" |
| **Keyword group 2 – Intervention**<br><br>Searched for in title, abstract and indexing terms/keywords (where available) | "professional development" OR "PD" OR "career development" OR "talent development" OR "leadership development" OR "executive development" OR "human resource development" OR "skill development" OR "skills development" OR "skill acquisition" OR "skills acquisition" OR "capacity development" OR "capacity building" OR "workforce development" OR "workplace development" OR "work place development" OR "workplace learning" OR "work place learning" OR "continuing development" OR "continuing learning" OR |

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| | "lifelong development" OR "lifelong learning" OR "personal development" OR "practice based development" OR "practice based learning" OR "professional learning" OR "professional education" OR "career education" OR "leadership education" OR "continuing education" OR "lifelong education" OR "executive education" OR "workplace education" OR "work place education" OR "practice based education" OR "training" OR "CPD" OR "CPE" OR "learning and development" OR "L&D" OR "knowledge acquisition" OR "knowledge transfer" OR "knowledge sharing" OR "upskilling" OR "up-skilling" OR "reskilling" OR "re-skilling" OR "accreditation" OR "coaching" OR "human capital development" OR "leadership development" OR "talent development" OR "mentoring" OR "adult learning" OR "learning culture" OR "learning organisation" OR "competency development" OR "competencies development" OR "competency acquisition" OR "competencies acquisition" OR "network development" OR "network acquisition" |
| **Keyword group 3 – Methodology**<br><br>Searched for in title, abstract and indexing terms/keywords (where available) | "field experiment" OR "field experiments" OR "field study" OR "field studies" OR "natural experiment" OR "natural experiments" OR "quasi experiment" OR "quasi-experiment" OR "quasi experiments" OR "quasi-experiments" OR "quasi-experimental" OR "quasi experimental" OR "experimental design" OR "experimental study" OR "experimental evidence" OR "controlled trial" OR "control trial" OR "controlled trials" OR "control trials" OR RCT* OR "random experiment" OR "random experiments" OR "random assignment" OR "random assignments" OR "random allocation" OR "random allocations" OR "random trial" OR "random trials" OR "random treatment" OR "random treatments" OR "random intervention" OR "random interventions" OR "random comparison" OR "random comparisons" OR "randomised assignment" OR "randomised assignments" OR "randomised allocation" OR "randomised allocations" OR "randomised trial" OR "randomised trials" OR "randomised treatment" OR "randomised treatments" OR "randomised intervention" OR "randomised interventions" OR "randomised comparison" OR "randomised comparisons" OR "randomized assignment" OR "randomized assignments" OR "randomized allocation" OR "randomized allocations" OR "randomized trial" OR "randomized trials" OR "randomized treatment" OR "randomized treatments" OR "randomized intervention" OR "randomized interventions" OR "randomized comparison" OR "randomized comparisons" OR "randomized controlled trial" OR "randomized controlled trials" OR "pretest posttest" OR "pretest-posttest" OR "pre/post" OR "before-after" OR "difference-in-differences" OR "difference-in-difference" OR "diff-in-diff" OR "propensity score" OR "regression discontinuity" OR "RDD" OR "instrumental variable" OR "instrumental variables" OR "cohort study" OR "cohort studies" OR "control group" OR "control groups" OR "treatment group" OR "treatment groups" OR "impact evaluation" OR "causal analysis" OR "causal inference" OR "matching |

| | techniques" OR "covariate matching" OR "inverse probability weighting" OR "nearest neighbor matching" OR "nearest neighbour matching" OR "exact matching" OR "kernel matching" OR "interrupted time series" OR "synthetic control" OR "synthetic controls" OR "panel study" |
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# Study records

## Data management

To ensure the search process is comprehensive, transparent, and replicable, we use several tools for our systematic reviews and general documentation. Please see the next section for more details on the process of study selection.

- **Implementation of search strategy**:
    - o **A Research Activity Sheet (RAS)** to record all searched terms, accessed sources, the date of the search and the number of search results. This will be within Excel.
- **Identification:**
    - o **Zotero**: We will record and maintain a list of the retrieved references in a specialist bibliographic software package called Zotero. Zotero is a free, open-source reference management tool that stores citation information (e.g., author, title, and publication fields) and has the ability to organise and tag that information, as well as identify duplicates. This will be used to store the collection of **records identified** by the searches. Zotero will also be used to deduplicate the list of records to ensure there is no repetition. We will document both the record identified and number of records removed due to deduplication in the PRISMA flowchart (see Figure 1).
- **Screening**:
    - o **Rayyan:** For the **screening** process, we will use Rayyan software. Rayyan is a free-to-use software to support systematic reviews, that allows the process of screening to be sped up through the use of a visual, colour-coded interface that highlights keywords associated with the eligibility criteria. It also documents the screening decisions of multiple reviewers for reconciliation and assessing the inter-rater reliability score. The screening process is detailed in the next section. We will export a list of all studies screened, the decision on inclusion/exclusion at what stage and if applicable, the reason for exclusion to Excel and it will be documented in the PRISMA flowchart.
- **Included records:**
    - o **A Research Extraction Sheet (RES)** which will provide a detailed log of all evidence included in the review. This will be held in Excel for ease of use and dissemination. The RES contains the following sheets:
        - ▪ **Records screened**: This sheet will consist of an export from Rayyan to Excel and include the eligibility decision for records after deduplication from all information sources (see above).
        - ▪ **Records included in the review**: The final list of studies to be included in the systematic review.
        - ▪ **Data extraction and synthesis**: The RES will capture all information extracted from the studies included in the review. See sections *'Data collection process and*

> data items' as well as 'Coding for synthesis' for more details on what data items will be presented in this sheet.

- **Analysis and Reporting:**
  - o **Analysis**: All code related to the analysis will be carried out using widely used statistical software, such as R. The code will be suitably labelled and documented to facilitate replication and quality checks. It will be published with the final report.
  - o **Log of any changes made after pre-registration** or issues encountered during systematic review
  - o **PRISMA checklist** will be produced during the reporting phase
  - o **Proprietary Alma Economics software** to develop an interactive evidence map to visually represent the evidence.
  - o **Quality Assurance (QA) logs**: We will maintain QA logs to document all feedback and issues raised during quality checks. Our QA process consists of an internal QA process and external QA from our academic partners from the EPPI and our partner Julie Glanville. QA will happen throughout the project but the most notable parts of QA are (i) the review of the systematic review protocol before pre-registration, (ii) the inclusion/exclusion pathway, (iii) the Research Extraction sheet and (iv) the code used during the synthesis.

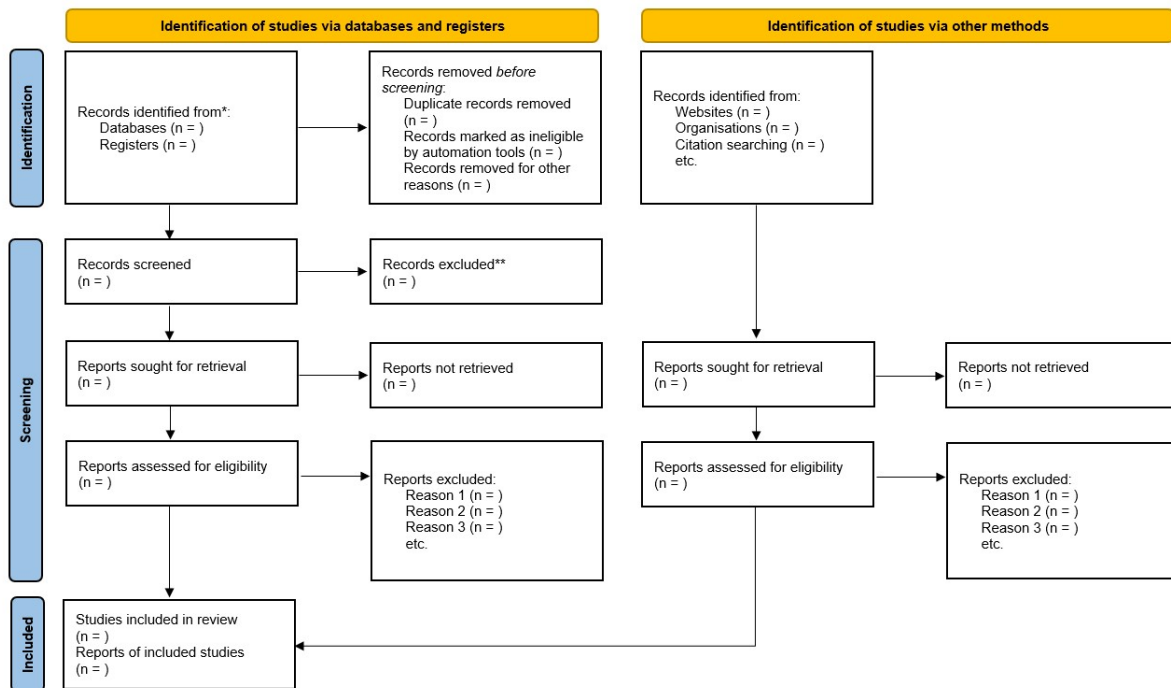# Study selection process

Our selection process follows the steps:

- **Identification**:
  - o We store all records identified from our database searches and other search methods described in the '*Information Sources'* section above, in Zotero, clearly indicating from which sources the records were identified.
  - o After storing the records, we will start the selection process by removing duplicate records. We will document how many duplicates were removed in the PRISMA flow chart (see Figure 1 below).
- **Screening**:
  - o **Title/Abstract:** Our interdisciplinary team will then start the screening process by scanning the titles and abstracts of records and applying the eligibility criteria to decide which studies should be retrieved for full-text screening in Rayyan. During this step, we will implement partial double screening, initially reviewing 10% of the records with two reviewers independently. If the agreement reaches 90%, we will transition to single screening; otherwise, we will continue double screening in batches of 50 records until a minimum of 90% agreement is achieved. Throughout the process, reviewers will hold regular discussions to ensure consistency in study inclusion and exclusion. We anticipate that the information regarding 'Date of publication,' 'Type of publication,' and 'Language of publication' will be accessible either through database filters or during the title and abstract screening. We will not conduct full-text searches for these specific criteria. If this information is not available at the title and abstract stage, the record will be excluded. The decision on inclusion/exclusion of any records during screening titles and abstracts will be recorded in the RES and the PRISMA flowchart.
  - o **Full Text:** The full text of any record that has not been excluded at that point will be

retrieved. As not all eligibility criteria for each record can be checked in detail by looking at the title and abstract alone, we will screen the full text where needed to assess eligibility in Rayyan for any record that has not been excluded in the previous stage. For those eligibility criteria the screening hierarchy is as follows: 1) Geographical Focus, 2) Population, 3) Intervention, 4) Outcomes, 5) Methodology, 6) Comparator. Again, the eligibility decision and the reason for excluded records will be exported to Excel and documented in the RES and reported in the PRISMA flowchart.

- **Included**:
  - o The result of the selection process will be the number of studies included in the review.

The search process will be thoroughly documented to ensure transparency and replicability. Figure 1 presents the flow chart (PRISMA 2020) that will be used to summarise the results of implementing our selection process.

**Figure 1.  Search strategy – PRISMA 2020 Flow Diagram**



# Data collection process and data items

We will extract data from the studies that will be included in the review and used for the evidence mapping, the data synthesis and assessment of the evidence. This information will be documented in the 'Data and Synthesis' sheet of the RES, as discussed in the *'Data Management'* subsection of this protocol.

Our approach to data synthesis and the assessment of the evidence are discussed in more detail in subsequent sections of the protocol.

We envision that we will extract the following data items, but this might have to be adjusted once the included studies have been identified.

**Table 2. Data items**

| Evidence Map | |
|---|---|
| **Category** | **Detail** |
| **Bibliographic information** | <ul><li>Title</li><li>Authors</li><li>Type of publication</li><li>Publication date</li><li>Source</li><li>Conflict of interest disclosed: Yes \| No</li></ul> |
| **Study characteristics** | <ul><li>Country of focus</li><li>Time period covered</li><li>Methodology:<ul><li>Study Design</li><li>Comparator</li><li>Process evaluation elements reported: Yes \| No</li></ul></li><li>Population:<ul><li>Professions: Operational delivery \| Policy \| Digital, Data & Technology \| Project Delivery \| Tax \| Other civil service</li><li>Sector: Civil Service \| Wider public sector (incl. charities/non-profits) \| Private sector</li><li>Seniority: Junior (Entry-level position, no team or project management) \| Mid-Level Management (Positions such as team leads or supervisors with moderate experience)\| Senior Management (Experienced professionals that oversee teams or significant projects) \| Executive Leadership (High-level executives such as directors, commissioners or C-suite executives) \| Unclear/Unreported</li><li>Gender: % female or non-binary \| Unclear/Unreported</li><li>Ethnicity: % non-white \| Unclear/Unreported</li><li>Age: Average age \| Unclear/Unreported</li></ul></li><li>Interventions:<ul><li>Level: Individual \| Team \| Organisation \| Unclear/Unreported</li><li>Group size intervention: Individual \| 2-5 \| 6-10 \| 10-20 \| 20-50 \| 50+ \| Mixed (Report all that apply) \| Unclear/Unreported</li><li>Duration of the intervention in total: (Numeric in hours) \| Unclear/Unreported</li></ul></li></ul> |

- - - o Frequency of sessions: Numeric | Unclear/Unreported
    - o Type of Engagement: Online – Synchronous | Online – Asynchronous | Face to face – Residential | Face to face – Workplace | Mixed (Report all that apply) | Unclear/Unreported
    - o Design: Internal | External | Unclear/Unreported
    - o Delivery: Internal | External | Self-Administered | Mixed (Report all that apply) | Unclear/Unreported
    - o Attendance: Voluntary | Compulsory | Mixed | Unclear/Unreported
    - o Type: Lecture/Seminar | Coaching | High-tech simulation-based learning | Low-tech simulation-based learning | Coaching | Action learning sets | Other (In vivo) | Mixed (Report all that apply) | Unclear/Unreported
  - Outcomes:
    - o Category of targeted outcome: Skills | Knowledge | Network | Work performance | Productivity
    - o Outcome as described in study
    - o Outcome measure as described in study

**Additional coding for synthesis**

| Category | Detail |
|---|---|
| **Quantitative data for the Meta-analysis** | <ul><li>Sample Size (N Overall, N Intervention, N Control)</li><li>Effect Size (e.g., OR, RR, MD)</li><li>95% CI (Lower - Upper)</li><li>Mean (Intervention / Control)</li><li>SD (Intervention / Control)</li><li>P-value</li><li>Timing of outcome measurement after intervention: Numeric \| Multiple (Report all) \| Unclear/Unreported</li></ul> |
| **Mechanisms** | <ul><li>We will code which mechanisms of the developed taxonomy appear in each intervention. The taxonomy will be developed during the systematic review, as discussed in the '*Plan for the development of taxonomy'* section.</li></ul> |
| **Risk of bias assessment** | <ul><li>Following tools specified in *'Risk of bias in individual studies'* section</li></ul> |
| **Confidence in cumulative evidence** | <ul><li>Following tools specified in *'Confidence in cumulative evidence section'*</li></ul> |

The reviewer team (see Personnel) will discuss each element of the data extraction table in detail to ensure the team is briefed and has a shared understanding of each data element. We will then pilot the data extraction to determine if additional guidance or definitions are required. We will conduct independent double extraction on 10% of the sample of randomly selected studies. Through investigator triangulation, two reviewers will separately extract study characteristics and numerical outcome data from studies that meet the eligibility criteria.

**Discrepancy Resolution Procedure**:

- Any discrepancies will be discussed in agreement meetings.

- If reviewers cannot reach a consensus, a third reviewer will be consulted for a final decision.

- Full agreement on all assigned codes in this subset must be achieved before proceeding with further single extraction.

If concerns about the interpretation persist after this phase, the team will assess whether additional double extraction or further refinements to the tool are necessary to resolve these issues.

# Plan for the development of a taxonomy

During our systematic review of the evidence, we will develop a coding framework designed to capture the specific mechanisms underpinning each intervention. The coding framework will be applied during the synthesis stage to systematically analyse and compare the effectiveness of different learning and development interventions.

We plan to use the Behavioural Change Technique (BCT) taxonomy as a base for the development of a taxonomy for this systematic review, given the existing precedent of having been successfully applied by Sims et al. (2021). The BCT taxonomy organises 93 mechanisms into 16 groups. . We will also collaborate and factor in steers from Government Skills and sector experts on the taxonomy as part of the scoping phase of the work. To ensure the adapted taxonomy is fit for purpose and a relevant, useful and intuitive framework to categorise public sector professional development mechanisms for policymakers and other practitioners, we will perform the following three-step process:

- **Testing and Refining BCT taxonomy on an initial sample of studies:** Once the study selection process has been completed, we will test the mechanisms in the BCT taxonomy against a selected sample of 20 studies eligible for inclusion in the review. The 20 studies will be selected to ensure, where possible, a balanced representation across eligibility criteria, including targeted population, outcomes, methodology, and publication date. The mechanisms in each of these 20 studies will be iteratively coded until they are judged to be suitably relevant and applicable. Following this step, to arrive at a draft taxonomy we expect to (i) remove irrelevant mechanisms or those that are not applied in a public sector professional development context, (ii) refine definitions to make them more relevant to the public sector, (iii) simplify mechanisms, for example by merging mechanisms that are deemed too granular to be useful or where strong overlaps exist between mechanisms, and (iv) add mechanisms that were missing from the BCT taxonomy but are present in the public sector professional development literature. This sample coding will also allow us to iteratively refine and operationalise the definitions of the mechanisms in a consistent and standardised way.

- **Refining the draft taxonomy after initial feedback:** Once the draft taxonomy is developed, we will consult with Government Skills and the project advisory board to further refine it.

- **Finalising of taxonomy and approach to coding:** During the synthesis, each study which is

included in the review will be coded by our team of researchers using the taxonomy. We will include a review point after coding about 50% of all included studies and discuss among the team whether there is a significant indication that the taxonomy needs to be adapted. We will also consider whether grouping or aggregating certain mechanisms might be beneficial for some steps of the synthesis or for the practical use of the taxonomy tool.

# Assessment of risk of bias in individual studies

To address the issue of potentially biased size estimate, we will use the following tools depending on the type of studies:

- **Randomised control trials**: For the RCTs, we will use the RoB 2 tool (Risk of Bias 2), a comprehensive framework developed for assessing bias in randomised studies (Sterne et al., 2019).
- **Quasi-experimental studies**: For quasi-experimental studies, the ROBINS-I tool (Risk Of Bias In Non-randomized Studies - of Interventions) will be applied, which is designed to evaluate bias in studies where participants are not randomly assigned to intervention groups (Sterne et al., 2016).

Using both tools allows for a robust evaluation of study quality across different research designs. We will not exclude studies based on our assessment of methodological limitations. Instead, this information will be documented in the report and used to assess our confidence in the review findings.

After conducting the risk of bias assessment, we will use the information gained during this process to inform our data synthesis. When presenting and interpreting the results of individual studies and syntheses, it is important to account for the risk of bias in the included studies. Various analytic strategies can be employed to assess the impact of bias on the results: (i) conducting a sensitivity analysis by limiting the primary analysis to studies with a low risk of bias; (ii) using subgroup analysis or meta-regression to stratify studies based on their risk of bias; or (iii) adjusting the results from each study to mitigate the influence of bias. Depending on the results of our risk assessment we will explore each of these options.

# Evidence mapping and data synthesis

The approach to synthesis will vary depending on the research question, the number of studies included, the homogeneity between studies, the methodologies used, and the quality and completeness of the data. This section outlines the approach for each research question:

**Research question 1: What are the characteristics of the studies and interventions in the experimental impact evaluation literature on professional development design in the civil service context and adjacent contexts?**

The findings of our first research question will be presented by employing a systematic evidence map. An evidence map involves conducting a comprehensive search across a broad field, followed by coding the identified studies based on specific characteristics. All studies that have been included in the review will be coded according to the criteria of the extraction tool presented in the '*Data collection process and data items'* section of this protocol. The findings of the systematic evidence mapping will be presented in a user-friendly table format in the appendix of the report and an interactive evidence map to visually represent the evidence using proprietary Alma Economics software. In the main text of the report, the information of this table will be presented in a descriptive manner, including descriptive statistics and potentially visual figures for clarity.

**Research question 2: Overall, how effective are professional development interventions in the civil service context at improving knowledge, skills, networks, work performance and productivity?**

The aim is to synthesise the evidence for this research question by conducting a meta-analysis. Meta-analysis is a statistical approach that combines the outcome data from individual studies to produce an overall estimate of the direction and size of the effect, along with an indication of the precision of the estimate. This method is particularly appropriate for this review because it integrates results from multiple studies, increasing the statistical power to detect overall effects. By providing a more robust and comprehensive understanding of the effectiveness of professional development interventions, meta-analysis enables more objective and quantifiable conclusions than a traditional narrative review.

To provide a comprehensive overview of the evidence, this analysis will include all studies that supply sufficient data to calculate an effect size for the targeted outcomes. Outcome data from individual studies will be transformed into a common metric (e.g. Standardised Mean Difference, SMD Hedges' g) to facilitate comparison and combination. The meta-analysis will then combine those standardised effect sizes. The interpretation of SMD will focus on the direction and size of the effect, where g = 0 indicates no difference between groups, values less than zero favour the control, and values greater than zero favour the intervention. The analysis will include 95% confidence intervals (C.I.) to assess the precision of the estimated effect, with particular attention to whether the C.I. crosses g = 0, which would indicate uncertainty about the true effect. A Random Effects Model will be used to account for differences between studies, with the I$^2$ statistic measuring heterogeneity to determine whether variability between studies impacts the overall result. Please consult the '*Approach to quantitative analysis*' section of this protocol to see how we deal with common data issues when using meta-analysis.

To determine whether a meta-analysis is feasible and the synthesis of effect estimates is both valid and informative, we will assess several key factors (McKenzie & Brennan, 2024 - Cochrane Handbook): i) number of studies with an appropriate study design and complete reported effect estimates, ii) comparability of studies across their key characteristics (PICO), especially for interventions and outcomes, iii) bias in the evidence and iv) statistical heterogeneity which explores the variation in effect estimates between studies. The alternative synthesis method used in case the meta-analysis is not feasible will depend on which factors preclude a meta-analysis. We will still aim to present a visual description of the evidence and will look into using Albatross plots (Harrison et al. 2017) to do so. Another method of synthesis in case meta-analysis is not possible is that we will describe and synthesise study findings narratively following the SWiM reporting guideline (Campbell, 2020). SWiM enhances transparency in systematic reviews by providing clear guidelines for reporting narrative synthesis methods, which improves the credibility and reproducibility of reviews where meta-analysis is not feasible.

To understand how the outcome of interventions varies according to study contexts and methods, we will conduct a subgroup meta-analysis. Since all our study characteristics are categorical variables, we will use subgroup meta-analyses with inverse variance weighting to explore whether there is statistical variation between effect sizes grouped according to key study characteristics.

We anticipate the following to be of interest, but these may be refined as we interact with the studies and either identify new important issues to consider, or discover insufficient data to conduct a given subgroup analysis:

- Publication type (journal, working paper, research report)
- Form of the comparison group (no intervention, alternative intervention)
- The type of outcome targeted (skill, knowledge, network, work performance, productivity)

- Population type (subgroup analysis for professions, sector, seniority)
- Intervention type (subgroup analysis for duration and type of engagement)
- Publication date (subgroup analysis for 2004-2013 & 2014-2024)

Please note though that once again there might not be enough comparable studies to conduct the meta-analysis and alternative methods of synthesis will have to be explored.

### Research question 3: Which design features and forms of professional development are associated with the greatest impact?

To understand which forms of professional development exist in the literature and which forms are more likely to be effective when incorporating particular combinations of mechanisms, we will employ elements of qualitative comparative analysis (QCA) (e.g., HM Treasury Magenta Book, Hanckel et al. 2021, El Sherif et al. 2024). QCA is particularly well-suited to investigate this research question because it allows for the examination of multiple conjunctural causation. This means that QCA can identify how combinations of different mechanisms—rather than single mechanisms in isolation—contribute to the success or failure of interventions. This approach recognises that outcomes are often the result of complex interactions between various mechanisms, rather than being attributable to any one factor.

We will code each study included in the review to indicate the presence (1) or absence (0) of the mechanisms from our taxonomy within the intervention. Based on this coding, we will create a truth table that displays, for each study, the binary codes representing the mechanisms present and the success or failure of the intervention. This truth table will serve as the foundation for the QCA, enabling us to systematically identify which combinations of mechanisms are associated with successful outcomes. This method will help us to isolate the key components that contribute to effective professional development interventions and offer insights into how these components interact.

We are aware of the potential challenges associated with having a large number of mechanisms, as highlighted in Sims et al.'s (2021) comments regarding their truth table approach. Should we find that our truth table includes too many unique combinations, we will keep the option open to aggregate certain mechanisms to facilitate the identification of commonly occurring clusters. This flexibility will allow us to effectively refine our analysis and ensure that we can draw meaningful conclusions regarding the forms of professional development associated with the greatest impact.

After constructing the truth table, we will investigate which combinations of mechanisms are associated with the greatest impact through subgroup meta-analysis. Interventions will be grouped based on their specific combinations of mechanisms, and we will calculate effect sizes for each subgroup using inverse variance weighting[2]. This approach allows us to quantitatively compare the effectiveness of different configurations, identifying which combinations are most strongly linked to successful outcomes. By examining variations in effect sizes across these subgroups, we can pinpoint the most impactful combinations of mechanisms, providing valuable insights for optimising professional development interventions.

### Research question 4: What supports successful implementation of professional development interventions targeted at driving improvements in knowledge, skills, networks; work performance and productivity in the civil service context and adjacent contexts?

To synthesise the evidence for the last research question, we will focus on studies that included an implementation and process evaluation (IPE) element. The IPE can either take the form of a separate

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[2] Inverse variance weighting combines effect sizes from different studies, giving more weight to those with greater precision. This approach ensures that more reliable studies have a stronger influence on the results, reducing bias and enhancing the robustness of the meta-analysis.

evaluation or be a specific component within the study. During the coding, we will record which studies include an IPE element. Given the largely qualitative nature of the data collected during an IPE, as well as the heterogeneity in implementing the IPEs, we will synthesise the evidence in narrative form using thematic analysis. As in the systematic review by Jørgensen et al. (2018), we will code relevant information about the selected studies' IPE elements, organise these codes into descriptive categories, and develop them into analytical themes that provide explanatory insights into the IPE processes. We intend to follow Sims et al., 2021 and structure the thematic analysis around the following three questions:

- To what extent were interventions implemented as planned?
- What factors supported or obstructed effective implementation?
- What was the nature and effect of programme adaptations?

This method will help to identify support and barriers to the successful implementation of professional development interventions in the public sector. However, we intend to refine this approach based on the IPE elements presented in the included studies and potentially adapt the questions to the specific context.

# Approach to quantitative analysis

In this section, we identify how our quantitative analysis will address specific data-related issues.

## Data types outcomes

### Dichotomous outcomes

If our variables of interest are reported in dichotomous terms, we will use odds ratio or relative risks for reporting.

### Continuous outcomes

We expect a majority of our outcomes to be expressed as continuous variables. For those that are reported on the same scale, we will use the mean difference. For outcomes that are reported on different scales, we will use Hedges' $g$ for standardised mean differences (SMD). For both, we will report standard errors and 95% confidence intervals.

Should we need to combine binary and continuous data, where appropriate, we will use a cut-off point to convert the continuous data into binary for comparison. The definition of the cut-off point will be reviewed by a second reviewer.

## Missing data

In case we encounter studies that do not have the complete data needed for our meta-analysis analysis, we will attempt to contact the author(s) and request the necessary data, along with information on whether or not it can be assumed to be missing at random. If the necessary data to compute effect sizes cannot be retrieved from authors, we will consider imputing the missing data with replacement values. In this event, we will follow the Cochrane Handbook guidelines (Deeks, Higgins, & Altman, 2023 - Cochrane Handbook).

## Dependent effect sizes

In cases where multiple effect sizes are reported from the same study, or the same participants contribute to multiple outcomes, we will address the issue of dependent effect sizes. This dependency can lead to underestimated standard errors and inflated Type I error rates if not properly managed. To mitigate this, we will employ a two-step approach (Lopez-Lopez et al., 2018):

1) We will assess whether it is appropriate to select a single effect size per study, following a reductionist approach. This may involve choosing the most relevant outcome or time point based on our research question or computing a composite effect size when multiple outcomes are equally relevant.

2) If we determine that including multiple effect sizes per study is necessary to fully address our research question, we will adopt an integrative approach using robust variance estimation (RVE). RVE allows for the inclusion of all relevant effect sizes while accounting for their dependency, providing valid statistical inferences even when the exact nature of the dependency is unknown.

# Assessment of reporting biases

This assessment concerns the risk of bias in the results of a synthesis, such as a meta-analysis, which may arise from missing studies or incomplete results within studies. This type of bias can occur if the decision to publish a study or report specific results is influenced by the observed P value or the magnitude and direction of the effect. For instance, publication bias can occur if studies with statistically non-significant results are not submitted for publication, while selective non-reporting bias can arise if certain statistically non-significant results are omitted from published reports.

To partially mitigate the risk of publication bias, we are also reviewing grey literature, and we are sending out a call for evidence to identify relevant unpublished papers.

In case a meta-analysis is conducted, we will generate funnel plots to help assess the presence of publication bias or small-study effects (Sterne & Egger, 2001). In these plots, effect sizes from individual studies are plotted against their precision, with the precision typically represented by the inverse of the standard error. A symmetrical inverted funnel shape indicates that publication bias is unlikely and that results are evenly distributed across studies of different sizes. Asymmetry in the plot may suggest publication bias or other issues, prompting further investigation into the trial characteristics and methodological differences to determine the cause.

# Confidence in cumulative evidence

To assess the quality of and confidence in the evidence for all outcomes, we will assess our confidence in the body of evidence as a whole. We will draw on elements of the GRADE (Grading of Recommendations Assessment, Development and Evaluation) framework to outline our reasoning. However, we are aware of the limitations of GRADE for this specific context given its focus on health interventions. We will develop a context specific tool to assess the quality and confidence in the cumulative evidence once the study selection process has been completed.

# Reporting and outputs

Findings from the review will be presented in a report, summarizing the results of all analyses described in this protocol. The report will follow the PRISMA 2020 reporting guidelines to ensure transparency and consistency in the presentation of the review's methodology and findings. In addition to the report, we will produce one short, summary report for non-technical stakeholders, one dissemination workshop, practitioner-oriented tools and the taxonomy of evidence-based mechanisms developed during this systematic review.

Key data collected for the evidence mapping will be presented in the form of a table in the appendix of the report and summarised in the main text of the report. We will also create an interactive evidence

map tool to allow for easier and more structured access to the extracted data. In addition, the evidence map will allow for simplified grouping and categorising studies for further analysis.

# Administrative information

## Registration

Once finalised, this protocol will be registered on the UK government evaluation registry. Any deviations from the protocol will be reported in the final report.

## Timeline

| Dates | Activity | Staff responsible/leading |
|---|---|---|
| **July 2024** | Research team appointed | Government Skills |
| **October 2024** | Protocol to be registered | Alma Economics |
| **February 2025** | Submission of draft final report | Alma Economics |
| **March 2025** | Submission of final report | Alma Economics |

## Personnel

The members of the review team and their roles are outlined below.

- **Lawrence Newland** is a Director at Alma Economics and will be the Project Director for this review.
- **Dr Mark Newman** is a Reader at University College London and will be a Skills and Training Systematic Review and Meta-analysis expert for this project.
- **Dr Janice Tripney** is an Associate Professor of Social Policy at the Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI Centre), part of the Social Science Research Unit at the UCL Social Research Institute and will be a Skills and Training Systematic Review and Meta-analysis expert for this project.
- **Julie Glanville** is a highly qualified Academic Librarian with over 25 years of experience in systematic reviews and evidence synthesis and will conduct quality assurance throughout the review.
- **Daniel Haile** is a Principal Economist at Alma Economics, and he will be our team's Research Lead.
- **Maria Liapi** is a Senior Economist at Alma Economics and will be a lead reviewer.
- **Dr Anja Garbely** is a Senior Economist and Data Scientist at Alma Economics and will be a lead reviewer and provide statistical expertise.
- **Vicky Grant** is an Economist at Alma Economics and will provide reviewing capacity.

## Contributors to this protocol

- **Content**: Dr Anja Garbely (anja.garbely@almaeconomics.com), Maria Liapi, Daniel Haile
- **Quality Assurance**: Dr Mark Newman, Dr Janice Tripney, Julie Glanville, Expert Advisory

Group (see next section), Government Skills project team (see next section)

## Source of support

This is an independent report conducted by Alma Economics and commissioned and funded by Government Skills, which is part of the UK Cabinet Office. The main contact of Government Skills is Siobhan Dickens (siobhan.dickens1@cabinetoffice.gov.uk).

An Expert Advisory Group consisting of members of the civil service and external experts has also been established for monitoring and oversight over the systematic review.

Both Government Skills and the Expert Advisory Group supported the development of the scope, analytic framework, and key questions for this review. However, they will have no role in the selection of studies, quality assessment, or the synthesis of evidence other than giving expert advice.

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# Appendix A: Sample search strategy

## Web of Science

**TS**: TS stands for Topic Search. It refers to a search that looks for the specified terms within the title, abstract, and keywords of the articles indexed in the database.

**Exact search** turned on.

**S6 = 974 results (search ran 17 Oct 2024)**

|  | Type of keywords | Search String |
|---|---|---|
| S6 |  | S1 AND S2 AND S3 AND S4 AND S5 |
| S5 | Filter: Language | English |
| S4 | Filter: Publication dates | 2004-01-01 to 2024-09-01 |
| S3 | Methodology | TS=("field experiment" OR "field experiments" OR "field study" OR "field studies" OR "natural experiment" OR "natural experiments" OR "quasi experiment" OR "quasi-experiment" OR "quasi experiments" OR "quasi-experiments" OR "quasi-experimental" OR "quasi experimental" OR "experimental design" OR "experimental study" OR "experimental evidence" OR "controlled trial" OR "control trial" OR "controlled trials" OR "control trials" OR RCT* OR "random experiment" OR "random experiments" OR "random assignment" OR "random assignments" OR "random allocation" OR "random allocations" OR "random trial" OR "random trials" OR "random treatment" OR "random treatments" OR "random intervention" OR "random interventions" OR "random comparison" OR "random comparisons" OR "randomised assignment" OR "randomised assignments" OR "randomised allocation" OR "randomised allocations" OR "randomised trial" OR "randomised trials" OR "randomised treatment" OR "randomised treatments" OR "randomised intervention" OR "randomised interventions" OR "randomised comparison" OR "randomised comparisons" OR "randomized assignment" OR "randomized assignments" OR "randomized allocation" OR "randomized allocations" OR "randomized trial" OR "randomized trials" OR "randomized treatment" OR "randomized treatments" OR "randomized intervention" OR "randomized interventions" OR "randomized comparison" OR "randomized comparisons" OR "randomized controlled trial" OR "randomized controlled trials" OR "pretest posttest" OR "pretest-posttest" OR "pre/post" OR "before-after" OR "difference-in-differences" OR "difference-in-difference" OR "diff-in-diff" OR "propensity score" OR "regression discontinuity" OR "RDD" OR "instrumental variable" OR "instrumental variables" OR "cohort study" OR "cohort studies" OR "control group" OR "control groups" OR "treatment group" OR "treatment groups" OR "impact evaluation" OR "causal analysis" OR "causal inference" OR "matching techniques" OR "covariate matching"OR "inverse probability |

| | | |
|---|---|---|
| | | weighting" OR "nearest neighbor matching" OR "nearest neighbour matching" OR "exact matching" OR "kernel matching" OR "interrupted time series" OR "synthetic control" OR "synthetic controls" OR "panel study") |
| S2 | Intervention | TS=("professional development" OR "PD" OR "career development" OR "talent development" OR "leadership development" OR "executive development" OR "human resource development" OR "skill development" OR "skills development" OR "skill acquisition" OR "skills acquisition" OR "capacity development" OR "capacity building" OR "workforce development" OR "workplace development" OR "work place development" OR "workplace learning" OR "work place learning" OR "continuing development" OR "continuing learning" OR "lifelong development" OR "lifelong learning" OR "personal development" OR "practice based development" OR "practice based learning" OR "professional learning" OR "professional education" OR "career education" OR "leadership education" OR "continuing education" OR "lifelong education" OR "executive education" OR "workplace education" OR "work place education" OR "practice based education" OR "training" OR "CPD" OR "CPE" OR "learning and development" OR "L&D" OR "knowledge acquisition" OR "knowledge transfer" OR "knowledge sharing" OR "upskilling" OR "up-skilling" OR "reskilling" OR "re-skilling" OR "accreditation" OR "coaching" OR "human capital development" OR "leadership development" OR "talent development" OR "mentoring" OR "adult learning" OR "learning culture" OR "learning organisation" OR "competency development" OR "competencies development" OR "competency acquisition" OR "competencies acquisition" OR "network development" OR "network acquisition") |
| S1 | Population | TS=("civil service" OR "civil servant" OR "civil servants" OR "public sector" OR "public administration" OR "public administrators" OR "public management" OR "government employee" OR "government employees" OR "government worker" OR "government workers" OR "government workforce" OR "government work force" OR "government staff" OR "government personnel" OR "government agency" OR "government agencies" OR "government official" OR "government officials" OR "government department" OR "government departments" OR "public employee" OR "public employees" OR "public worker" OR "public workers" OR "public workforce" OR "public work force" OR "public staff" OR "public personnel" OR "public manager" OR "public managers" OR "public official" OR "public officials" OR "public service employee" OR "public service employees" OR "public service worker" OR "public service workers" OR "public service workforce" OR "public service work force" OR "public service staff" OR "public service personnel" OR "public service manager" OR "public service managers" OR "public service official" OR "public service officials" OR "public servant" OR "public servants" OR "federal employee" OR "federal employees" OR "federal worker" OR "federal workers" OR "federal workforce" OR "federal work force" OR "federal staff" OR "federal personnel" OR "federal agency" OR "federal agencies" OR "federal official" OR "federal officials" OR "state employee" OR "state employees" OR "state worker" OR "state workers" OR "state workforce" OR "state work force" OR "state staff" OR "state personnel" OR "state agency" OR "state agencies" |

OR "state official" OR "state officials" OR "local government" OR "local governments" OR "local official" OR "local officials" OR "local authority" OR "local authorities" OR "municipal government" OR "municipal governments" OR "municipal employee" OR "municipal employees" OR "municipal worker" OR "municipal workers" OR "municipal workforce" OR "municipal work force" OR "municipal staff" OR "municipal personnel" OR "municipal official" OR "municipal officials" OR "regional government" OR "regional governments" OR "regional employee" OR "regional employees" OR "regional worker" OR "regional workers" OR "regional workforce" OR "regional work force" OR "regional staff" OR "regional personnel" OR "regional official" OR "regional officials" OR "operational employee" OR "operational employees" OR "operational worker" OR "operational workers" OR "operational workforce" OR "operational work force" OR "operational staff" OR "operational manager" OR "operational managers" OR "government front office" OR "government back office" OR "public service operations" OR "government operations" OR "court employee" OR "court employees" OR "court worker" OR "court workers" OR "court work force" OR "court workforce" OR "court staff" OR "prison employee" OR "prison employees" OR "prison worker" OR "prison workers" OR "prison workforce" OR "prison work force" OR "prison officer" OR "prison officers" OR "prison staff" OR "prison manager" OR "prison managers" OR "tribunal officer" OR "tribunal clerk" OR "court service officer" OR "border force officer" OR "border force officers" OR "immigration officer" OR "immigration officers" OR "customs officer" OR "customs officers" OR "probation officer" OR "probation officers" OR "civil enforcement officer" OR "public service bailiff" OR "enforcement officer" OR "passport control officer" OR "passport control officers" OR "visa processing officer" OR "visa processing officers" OR "consular employee" OR "consular employees" OR "consular worker" OR "consular workers" OR "consular workforce" OR "consular work force" OR "consular officer" OR "consular officers" OR "consular staff" OR "consular manager" OR "consular managers" OR "job centre employee" OR "job centre employees" OR "job centre worker" OR "job centre workers" OR "job centre workforce" OR "job centre work force" OR "job centre staff" OR "job centre manager" OR "job centre managers" OR "job center employee" OR "job center employees" OR "job center worker" OR "job center workers" OR "job center workforce" OR "job center work force" OR "job center staff" OR "job center manager" OR "job center managers" OR "work coach" OR "work coaches" OR "call centre employee" OR "call centre employees" OR "call centre worker" OR "call centre workers" OR "call centre workforce" OR "call centre work force" OR "call centre staff" OR "call centre manager" OR "call centre managers" OR "call center employee" OR "call center employees" OR "call center worker" OR "call center workers" OR "call center workforce" OR "call center work force" OR "call center staff" OR "call center manager" OR "call center managers" OR "employment advisor" OR "employment advisors" OR "customer service employee" OR "customer service employees" OR "customer service worker" OR "customer service workers" OR "customer service workforce" OR "customer service work force" OR "customer service staff" OR "customer service representative" OR "customer service representatives" OR "customer service advisor" OR "customer service advisors" OR "policy advisor" OR "policy advisors" OR "policy staff" OR "policy officer" OR "policy officers" OR

"policy adviser" OR "policy advisers" OR "policy design" OR "policy designing" OR "policy delivery" OR "policy advice" OR "policy briefing" OR "policy implementation" OR "policy implementing" OR "policy evaluation" OR "policy evaluations" OR "policy evaluating" OR "strategy design" OR "strategy designing" OR "strategy delivery" OR "strategy advisor" OR "strategy advisors" OR "strategy advice" OR "strategy briefing" OR "strategy implementation" OR "strategy implementing" OR "strategy evaluation" OR "strategy evaluations" OR "strategy evaluating" OR "policy official" OR "policy delivering" OR "policy advising" OR "policy research" OR "policy consultation" OR "policy legislation" OR "strategy designing" OR "strategy advising" OR "business architect" OR "business architects" OR "data architect" OR "data architects" OR "enterprise architect" OR "enterprise architects" OR "network architect" OR "network architects" OR "security architect" OR "security architects" OR "solution architect" OR "solution architects" OR "technical architect" OR "technical architects" OR "analytics engineer" OR "analytics engineers" OR "data analyst" OR "data analysts" OR "data engineer" OR "data engineers" OR "data ethicist" OR "data ethicists" OR "data governance manager" OR "data governance managers" OR "data scientist" OR "data scientists" OR "machine learning engineer" OR "machine learning engineers" OR "performance analyst" OR "performance analysts" OR "application operations engineer" OR "application operations engineers" OR "business relationship manager" OR "business relationship managers" OR "change and release manager" OR "change and release managers" OR "command and control centre manager" OR "command and control centre managers" OR "end user computing engineer" OR "end user computing engineers" OR "it service manager" OR "it service managers" OR "incident manager" OR "incident managers" OR "infrastructure engineer" OR "infrastructure engineers" OR "infrastructure operations engineer" OR "infrastructure operations engineers" OR "problem manager" OR "problem managers" OR "service desk manager" OR "service desk managers" OR "service transition manager" OR "service transition managers" OR "business analyst" OR "business analysts" OR "delivery manager" OR "delivery managers" OR "digital portfolio manager" OR "digital portfolio managers" OR "product manager" OR "product managers" OR "programme delivery manager" OR "programme delivery managers" OR "program delivery manager" OR "program delivery managers" OR "service owner" OR "service owners" OR "quality assurance testing analyst" OR "quality assurance testing analysts" OR "qat analyst" OR "qat analysts" OR "test engineer" OR "test engineers" OR "test manager" OR "test managers" OR "development operations engineer" OR "development operations engineers" OR "devops engineer" OR "devops engineers" OR "frontend developer" OR "frontend developers" OR "software developer" OR "software developers" OR "accessibility specialist" OR "accessibility specialists" OR "content designer" OR "content designers" OR "content strategist" OR "content strategists" OR "graphic designer" OR "graphic designers" OR "interaction designer" OR "interaction designers" OR "service designer" OR "service designers" OR "technical writer" OR "technical writers" OR "user researcher" OR "user researchers" OR "project delivery" OR "project manager" OR "project managers" OR "project management" OR "project lead" OR "project leader" OR "project leaders" OR "project leadership" OR "project admin" OR "project

<table>
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