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BTM STANDARDS INTEGRATION WITHIN TALENT MANAGEMENT PROCESSES: AN ONTOLOGY ENGINEERING APPROACH

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SOMMAIRE

La gestion des ressources humaines (GRH) repose fortement sur des processus de recrutement et de sélection efficaces pour attirer et employer les meilleurs candidats. Cependant, la complexité du problème de sélection du personnel présente des défis pour associer efficacement les exigences du poste avec les qualifications des candidats. Cette thèse aborde ces défis en exploitant les technologies du Web Sémantique (SW) pour développer une ontologie des emplois et des candidats en Gestion de la Technologie d'Affaires (BTM) en utilisant Protégé. Ensuite, le langage de règles du Web Sémantique (SWRL) est utilisé pour élaborer des règles qui associent et évaluent les qualifications des candidats par rapport aux exigences du poste. Ce processus d'appariement et d'évaluation intègre l'utilisation de l'appariement d'ontologies et des techniques de prise de décision multicritères (MCDM), spécifiquement la méthode de pondération additive simple (SAW). De plus, la méthodologie METHONTOLOGY employée et les motifs de conception d'ontologie (ODPs) assurent le suivi des meilleures pratiques en ingénierie ontologique. De même, la précision des résultats d'appariement et d'évaluation est vérifiée en utilisant l'analyse de la mesure F.

Cette approche basée sur l'ontologie permet une analyse systématique des exigences du poste et des qualifications des candidats avec un appariement et un classement efficaces. De plus, l'approche proposée améliore non seulement l'automatisation et la transparence dans les processus de recrutement et de sélection, économisant ainsi du temps et des coûts, mais aborde également les problèmes d'interopérabilité découlant de modèles de données divers et de normes en utilisant un ensemble unifié de technologies SW. La vision des technologies SW est d'équiper les données en ligne avec une sémantique bien définie et formelle qui peut être comprise et traitée par des machines, améliorant ainsi l'échange de données et les capacités de raisonnement entre différents outils.

Cette recherche contribue donc de manière significative au développement de solutions robustes basées sur l'ontologie pour sélectionner les meilleurs candidats pour les postes adéquats dans le domaine du BTM avec une intégration future potentielle dans les portails d'emploi BTM pour une meilleure utilisabilité, scalabilité et interopérabilité à travers des systèmes hétérogènes. L'initiative BTM unifie la discipline et la profession de la gestion des affaires, de la technologie et du management. Elle souligne l'expertise numérique à travers tous les rôles professionnels visant ultimement à transformer les organisations. Née à Toronto en 2009, la BTM a évolué indépendamment après le financement initial du gouvernement du Canada. Elle est maintenant offerte dans plusieurs universités canadiennes aux niveaux du premier cycle et des cycles supérieurs.

Mots-clés : Web Sémantique, Langage d'Ontologie du Web (OWL), Langage de Règles du Web Sémantique (SWRL), Logique de Description (DL), Raisonnement, Développement d'Ontologie, Appariement d'Ontologie, Prise de Décision Multicritère (MCDM), Pondération Additive Simple (SAW), Éditeur d'Ontologie Protégé, Recrutement, Sélection du Personnel, Emplois en Gestion de la Technologie d'Affaires (BTM).

ABSTRACT

Human Resource Management (HRM) relies heavily on efficient recruitment and selection processes to attract and employ best candidates. However, the complexity of the Personnel Selection (PS) problem presents challenges in effectively matching job requirements with applicant qualifications. This thesis addresses these challenges by leveraging Semantic Web (SW) technologies to develop a Business Technology Management (BTM) jobs-applicants ontology using Protégé. Then, Semantic Web Rule Language (SWRL) is used to develop rules that match and evaluate applicants' qualifications against job requirements. This matching and evaluation process incorporates the use of both ontology matching and Multi-Criteria Decision Making (MCDM) techniques, specifically the Simple Additive Weighting (SAW) method. Furthermore, the employed METHONTOLOGY methodology and Ontology Design Patterns (ODPs) ensure following best practices in ontology engineering. Likewise, the matching and evaluation results accuracy are further verified using F-measure analysis.

This ontology-based approach enables systematic analysis of job requirements and candidate qualifications with effective matching and ranking. Moreover, the proposed approach not only enhances automation and transparency in recruitment and selection processes thereby saving time and cost, but also addresses interoperability issues arising from diverse data models and standards by using a unified set of SW technologies. The vision of the SW technologies is equipping online data with a formal well-defined semantics that can be understood and procced by machines, thus, enhancing data exchange and reasoning capabilities among different tools.

This research, therefore, significantly contributes to the development of efficient ontology-based solutions for selecting best candidates for the right jobs in the BTM domain with potential future integration in BTM job portals for enhanced usability, scalability, and interoperability across heterogeneous systems. BTM initiative unifies business, technology, and management discipline and professional. It emphasizes digital expertise across all professional roles ultimately aiming to transform organizations. Born in Toronto in 2009, BTM has evolved independently after initial funding from the Government of Canada. It is now offered at several Canadian university at both undergraduate and graduate levels.

Key Words: Semantic Web, Web Ontology Language (OWL), Semantic Web Rule language (SWRL), Description Logic (DL), Reasoning, Ontology Development, Ontology Matching, Multi-Criteria Decision Making (MCDM), Simple Additive Weighting (SAW), Protégé Ontology Editor, Recruitment, Personnel Selection, Business Technology Management (BTM) jobs.

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List of Abbreviations

AHP	Analytic Hierarchy Process
ALC	Attributive Language with Complement
API	Application Programming Interface
BTM	Business Technology Management
BTM BOK	Business Technology Management Body of Knowledge
CAP	Concept Abduction Problem
CV	Curriculum Vitae
DL	Description Logics
DSRM	Design Science Research Methodology - Process Model
DSS	Decision Support System
DTS	Digital Transformation and Strategy
EDS	Ehlers Danlos syndrome - international classification system
eHRM	electronic Human Resource Management
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
FoET	Fields of Education and Training
FOL	First Order Logic
GATE	General Architecture for Text Engineering
GP	Goal Programming
GTA	Gestion des technologies d'affaire
HR	Human Resources
HR-XML	Human Resource Extensible Markup Language
HRM	Human Resource Management
HRMJ	Human Resource Management Journal
ICT	Information and Communication Technologies
IJHRM	International Journal of Human Resource Management
IS	Information Systems
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ISO	International Organization for Standardization
IT	Information Technology

ITAC	Information Technology Association of Canada
JSON	JavaScript Object Notation
JSON-LD	JavaScript Object Notation for Linked Data
LOA	Laboratory for Applied Ontology
MCDM	Multi Criteria Decision Making
MODM	Multi-Objective Decision Making
MOGA	Multi-Objective Genetic Algorithm
MSC	Management Standards Center
NACE	Nomenclature of Economic Activities – European statistical classification of economic activities
NOS	National Occupational Standards
ODPA	Association for Ontology Design and Patterns
ODPs	Ontology Design Patterns
OEP	Ontology Engineering Patterns
OWL	Web Ontology Language
PROMETHEE	Preference Ranking for Organization Method for Enrichment Evaluation
RAD	Rapid Application Development
RDF	Resource Description Framework
RUP	Rational Unified Process
SAW	Simple Additive Weighting
SEEMP	Single European Employment Market-Place
SFIA	Skills Framework for Information Age
SKOS	Simple Knowledge Organization System
SPARQL	SPARQL Protocol and RDF Query Language
SQWRL	Semantic Query-Enhanced Web Rule Language
SWRL	Sematic Web Rule Language
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
TOVE	Toronto Virtual Enterprise Ontology Editor
Turtle	Terse RDF Triple Language
URI	Uniform Resource Identifier
W3C	World Wide Web Consortium
XML	Extensible Markup Language

Chapter 1

Introduction

1.1 Context

In Human Resource Management (HRM) effective recruitment and selection of the best candidates is challenging. Traditional approaches to personnel selection are arguably inadequate involving scanning, personality testing, and interviewing an enormous number of candidates making the process time-consuming, error-prone, and thus imprecise.

This research bridges this gap by proposing a systematic approach that leverages Semantic Web technologies and Multi Criteria Decision Making (MCDM) principles to enhance the recruitment and selection processes. Specifically, it aims to semi-automate the matching and evaluation of candidates' qualifications against jobs' requirements by developing a comprehensive ontology that integrates jobs and job seekers facts using Web Ontology Language (OWL) in the Protégé ontology editor. Based on the developed ontology, Sematic Web Rule Language (SWRL) rules incorporating Simple Additive Weighting (SAW) formulas are used respectively to match and evaluate job seekers qualifications against jobs requirements. This process ensures efficient and accurate evaluations based on predefined matching and evaluation criteria.

This thesis uses Business Technology Management (BTM) jobs specifications as the dataset of the research. Based on several occupations' standards, the BTM initiative defines 27 jobs integrating business, technology, and management disciplines. Initiated in Toronto in 2009, BTM has independently evolved following initial funding from the Government of Canada. As a study program, BTM is offered at various Canadian universities at both undergraduate and graduate levels focusing on preparing these graduates to be leaders of digital transformation in their respective organizations.

The following sections overview the research topic, problem, objectives, and contribution in more details.

1.2 Overview

Recruiting and selecting the right talent is challenging especially with the high volume of applicants. Moreover, manual screening and classification of applicant's qualification by HRM

teams are not only resource-intensive but also prone to subjective biases. The recruitment process typically starts by posing a job offer that specifies, for instance, the role, description, requirements, qualification, skills, work experience and location. Then, interested applicants apply for the opening position by providing their qualifications and CV either online or by traditional means of mailing. Then, the selection process starts by screening, classifying, interviewing, and evaluating the applicants usually following traditional methods.

In this context, state-of-the-art technologies offer promising opportunities for automation and refinement of the selection process. These technologies require developing approaches for knowledge management, engineering, and representation. This research adopts semantic web technologies represented by OWL and SWRL to develop jobs-applicants ontology and ontology-based matching approach to enhance the process of selecting applicants. To evaluate the applicants systematically, the research integrates SAW method in the SWRL matching rules.

As an extension of the current web, semantic web aims to give online data a well-defined formal meaning that makes the data understood and processable by machines, thus, promoting automation. Semantic web defines several standards and technologies. Ontologies represent the key semantic web technology. An ontology is a way of representing domain knowledge by formally specifying a structure of concepts that can be instantiated along with their relations and properties. It represents a formal domain model that is based on Description Logics (DL) and reasoning. To implement the concepts of such formal DL-based ontology, semantic web technologies include OWL to model and express the ontologies by mapping DL concepts to classes, instances and their properties. In addition to formal knowledge representation, ontologies enhance reusing and sharing information.

Efforts on advancing ontology development have introduced several methods, methodologies, technologies and languages and principles that entitled the development to become an engineering discipline. Ontology engineering typically requires the involvement of domain experts, ontology engineers and ontology users. It also requires identifying a proper ontology development methodology and Ontology Design Patterns (ODP) based on a specific domain knowledge as well as the intention and the scope of the development.

Ontologies are valuable for ensuring systems interoperability by sharing and reusing knowledge across applications. Many distributed and heterogeneous systems commonly require the use of more than one ontology. Moreover, several parties are developing different ontologies for same

domains. Furthermore, diverse disciplines develop different ontologies according to various perspectives. All of which, thus, results in the heterogeneity problem.

In this context, ontology matching techniques can address the heterogeneity problem. The heterogeneity problem occurs especially when considering ontologies mapping and data exchange. Ontology matching techniques are typically used to find corresponds and match entities of different ontologies that have a semantic relation. It allows to compare those different ontologies and find correspondences in terms, classes, instances, and properties. The set of correspondences is known as alignment representing matched entities. Then, the alignment can be interpreted and processed according to applications needs and purposes such as ontology merging and query answering. Several ontology matching techniques that have been proposed are grouped on a structural and elemental level with various syntactic and semantic techniques. The basic techniques include string-based, language-based, linguistic resources, alignment reuse, upper-level ontologies, graph-based and model-based techniques. Furthermore, techniques can be combined to address complex matching scenarios resulting in forming large matching systems.

In terms of evaluating alternatives, MCDM offers numerous methods that can be used to evaluate applicants. It provides a structured process to determine the best applicants considering predefined criteria. This research uses SAW MCDM method. The SAW is a popular technique that determines best alternative by multiplying normalized values with assigned criteria weights and summing the products. It is used in this research because it offers a straightforward and effective decision-making approach to evaluate the applicants morever it is easy to integrate with the matching SWRL rules.

In the context of a case study and dataset, this research considers the emerging Business Technology Management (BTM) jobs specification with the aim of developing its jobs and job seekers ontology as well as their respective SWRL-SAW matching and evaluation technique. It represents a perfect target domain of analyzing and testing as it comprises business, technology, and management professions. Information Technology Association of Canada (ITAC) conducted several consultations and studies to formalize the BTM field with required learning outcomes and competency standards based on related national and international standards as well as academic institutions, industry, and sector associations. BTM specification groups 27 jobs into 3 main role sets (Analyst, Architect, Manager) and 5 major target professions (Financial Services, Digital Health, Data Analytics, Digital Security, Entrepreneurship, and Innovation). Each job defines competencies in 30 to 39 categories. Recently, BTM has independently evolved following the

initial funding from the Government of Canada. As a study program, BTM is offered at several Canadian universities at both undergraduate and graduate level[1].

1.3 Research Problem

The research problem lies in the domain of recruitment and selection of jobs applicants. Enhancing these processes is critical as it allows to minimize the time and the cost as well as hiring the right candidate. However, the recruitment process faces several challenges especially in terms of efficient automation, interoperability, jobs references reuse as well as selecting and evaluating the applicants. To address these challenges, this research focuses on using Semantic Web technologies, particularly OWL and SWRL, combined with the Multi-Criteria Decision Making (MCDM) evaluation represented by the Simple Additive Weighting (SAW) method.

Therefore, the research problem comprises two main parts. The first part involves the development of a comprehensive ontology for BTM jobs' requirements and applicants' qualifications based on the best practices used in ontology engineering. The second part requires the implementation of an effective matching and evaluation technique to enhance the automation and precision of the selection process. Thus, the research attempts to answer the following research questions:

RQ1- How can the selection process be enhanced in terms of automation, accuracy, time, and cost?

RQ2 - How can BTM jobs requirements be analyzed to extract specific concepts and relationships?

RQ3 - How can the BTM OWL ontology be designed and developed in accordance with best practices?

RQ4 - How can SWRL matching rules be identified and implemented with integrated SAW evaluation for efficient candidate assessment?

RQ5 - What methods that can be used to measure and evaluate the accuracy of matching and evaluation results?

RQ6 - How can the BTM jobs ontology and matching techniques be generalized to facilitate reuse across other domains with minimal modifications?

1.4 Research Objective

The main objective of this research is developing BTM jobs and applicants' ontology incorporating a matching and evaluation technique that enhances the selection process ultimately saving time and cost as wells as providing automation for better recruitment decision making. Subsequently, the

[1] https://cips.ca/btm/

research work aims to support BTM community studies and research. Moreover, the BTM jobs ontology and matching approach can feature as a prototype to address similar problems in various domains. The following subsections highlight the key aspects of the thesis objectives.

1.4.1 Ontology Development

The thesis aims to develop a comprehensive OWL ontology for BTM job requirements and job seeker qualifications using Protégé ontology editor. To achieve this aim, the thesis focuses on following well-established practices in ontology engineering. Such that, it adopts METHONTOLOGY methodology and principles of ontology Design Patterns (ODPs) to ensure a consistent and well-structured ontology.

1.4.2 SWRL and SAW Rule-based Matching and Evaluation

The study aims to assess and match applicants' qualifications to job requirements by identifying and developing matching rules and algorithms using SWRL rules with integrated SAW evaluation. This approach enables accurate and automated matching and evaluation of applicants according to the predefined criteria established by this thesis.

1.4.3 Automation and Efficiency

The subsequent key aspect of the objectives considers improving the automation and effectiveness of the selection process, thus personnel selection decision. This results in decreasing time and cost associated with conventional methods. Moreover, it simplifies the screening, categorization, and assessment of applicants ultimately leading to more accurate, transparent, and efficient decision-making results.

1.4.4 Interoperability and Reusability

Another key objective of this research is to enhance the recruitment interoperability challenges caused by varying data models and standards. Semantic Web technologies used in this thesis approach are built on established standards such as RDF, OWL, and SWRL. These standards naturally enhance interoperability by providing means of data exchange and reuse across different systems and platforms.

In this context, the development of the BTM jobs OWL ontology provides a structured, standardized model for representing both job requirements and applicants' qualifications. Therefore, it provides a formal, machine-readable knowledge representation, which makes it inherently interoperable with other HR systems that also leverage semantic technologies or adhere

to standards such as HR-XML. Moreover, utilizing OWL in the ontology ensures that jobs requirements and applicants qualifications are represented in a consistent, widely accepted format that enables facilitating data exchange and integration with external recruitment platforms, databases, and other HR-related systems. Furthermore, the use of SWRL rules allows for a flexible and expressive rule-based system that can be adapted or extended for use in other job domains. For instance, the BTM ontology can be easily extended to incorporate additional domain-specific vocabularies or linked to other ontologies in the HR domain. It, therefore, enables creating a broader interoperability and reusability of the ontology and the rules beyond the BTM domain, enabling efficient adaptation to different sectors, roles, or job markets with minimal adjustments.

Moreover, the standardized nature of the ontology and the flexibility of the matching rules allows for further integration with external databases, APIs, or web services. This further enhances the approach scalability and interoperability with other HR systems or recruitment platforms.

Accordingly, the developed BTM ontology-based matching and evaluation technique can be easily reused in various job domains with minor modifications, thus improving the efficiency, accuracy, and scalability of the recruitment process.

1.4.5 Results Accuracy Evaluation

The research seeks to provide a solution for improving BTM recruitment and selection processes and simultaneously shedding the lights and insights on the potential of ontology-based methods in enhancing HRM selection decision-making. Through empirical evaluation and F-measure accuracy validation, the goal is to demonstrate the effectiveness and accuracy of the proposed solution in mitigating personnel selection challenges.

1.5 Research Significance and Contribution

HRM is an essential part of any organization. The way this department operates affects the efficiency and the success of the organization. Therefore, Organizations of any size or type to provide best services and accomplish the objectives, must find best ways to manage and operate their Human Resources (HR) efficiently. Based on our study, however, the selection process lacks automation, objectivity, transparency, and reusability. Semantic web technologies such as OWL and SWRL can address such deficiencies. According to several studies, semantic web technologies are among the top ten disruptive technologies for 2008-2012, with approximately 278 papers published in major conferences and journals during 2000-2007 [1]. Because the vision of semantic web technology is to give formal meaning (semantics) to data, it provides more interesting and

accurate technologies to represent, manage and automate knowledge. Moreover, the selection of BTM jobs as the research case study is valuable as it significantly contribute to IT and next generation organizational digital transformation [2] [3]. Information and Communication Technologies (ICT) are important for any Organization to remain competitive. Therefore, it is essential for all organizations to manage their ICT resources and infrastructure. BTM professional aims to unify Business. Management, and Information Technology (IT) in a coherent specialization that allows solving business problems, developing business strategies, improve organizational processes, and performance by adapting recent and advanced technologies and methodologies.

This research significantly contributes to advancing the state-of-the-art in recruitment and selection processes. It promotes the adoption of Semantic Web technologies to address critical challenges in personnel selection considering BTM jobs requirements as a case study. The practical results of the research and its potential reuse highlight its significance in several key areas and contributions to both academia and industry in the domain of HRM personnel selection. The following subsections outline the significance and contribution of the research.

1.5.1 Advancing HRM Selection Process

The research addresses a common challenge faced by organizations in selecting the best candidates and minimizing associated time and cost. Based on the Semantic Web technologies and MCDM principles, this research introduces a systematic approach to enhancing recruitment and selection processes. The systematic integration of ontology-based jobs modeling and matching techniques contributes to advancing the personnel selection methods and offers more efficient, accurate, and automated procedures for selecting the right applicants. The automation and reformation of the selection process enables organizations to minimize associated costs and processing time substantially. Furthermore, the adoption of advanced semantic web technologies enhances transparency and resource allocation. Moreover, through the integration of matching and evaluation enabled by semantic web technologies and SAW, the research improves the accuracy and efficacy of candidate selection and evaluation. This approach also holds the potential of integration with job portals which facilitates reusability and scalability. Therefore, this research has the potential to revolutionize HRM operations with enhanced efficiency, transparency, and adaptability to the workforce dynamics.

1.5.2 BTM Jobs as a Case Study

BTM professions unify business, management, and IT expertise to solve modern business challenges and lead the digital transformation of organizations. This research pioneers the selection

of the BTM jobs as a primary case study as well as the use of SWRL in job requirements matching with the qualifications of job seekers. Thus, the research provides practical personnel selection solution to BTM community that can be reused with minor changes.

1.5.3 Promoting Semantic Web Technologies Adoption

Despite the critical role of the selection process, it often faces challenges represented by the lack of automation and objectivity which negatively impacts the resources, success, and growth of organizations. Leveraging Semantic Web technologies, particularly OWL and SWRL to build ontologies as well as reasoning and matching techniques, opens new opportunities, and approaches to mitigate these deficiencies and revolutionize knowledge representation, engineering, and automation.

1.5.4 Enhancing Reusability and Interoperability

By employing ontology engineering best practices, the proposed approach offers foundations for broader applicability across various jobs domains. Hence, it emphasizes the reusability and Interoperability of the developed ontology and matching techniques beyond personnel selection in the BTM domain.

1.5.5 Incorporating Empirical Validation and Evaluation

Through rigorous empirical validation and F-measure accuracy assessments, the research provides empirical evidence of the effectiveness and reliability of the proposed solution. This validation not only verifies the research approach results but also provides valuable insights in the practical implications and performance metrics of ontology-based jobs requirements and applicants qualifications modeling and matching.

1.6 Thesis Outline

This thesis is organized into seven main chapters, each focusing on specific aspects of leveraging Semantic Web technologies for enhancing recruitment and selection processes within HRM, specifically in the BTM jobs requirements and applicants' qualification matching and evaluation. This structure is designed to guide the reader through the thesis content, from the introduction of the problem to the detailed development of the solution, and finally, the conclusions drawn from the research findings. The following provides a brief description of each chapter:

Chapter 1: Introduction

The introduction chapter outlines the context, research problem, objectives, and significance of the study. It introduces the challenges faced in HRM recruitment and selection processes and proposes the use of Semantic Web technologies combined with MCDM principles as a solution.

Chapter 2: Literature Review

In this chapter, a comprehensive review of existing literature is presented. The chapter covers key concepts related to the thesis, including HRM practices, the Semantic Web technologies focusing on ontology development and matching, MCDM concepts especially SAW method, and the BTM domain background concentrating on its jobs specification and analysis serving the thesis case study. This chapter provides essential backgrounds and reviews related approaches that help in achieving the thesis objectives.

Chapter 3: Methodology

This chapter details the research methodology, including the use of the guiding Design Science Research Methodology (DSRM). The chapter then describes the processes involved in developing the BTM jobs ontology and the ontology-based matching and evaluation approach. It is providing insights into the theoretical and practical considerations underlying the research methodology.

Chapter 4: BTM Jobs Ontology Development

Focusing on the first key aspect of the thesis, this chapter explains the development of the BTM jobs ontology based on the METHONTOLOGY methodology. It covers the various phases of ontology development from specification to implementation and detailing the structure and components of the developed ontology.

Chapter 5: BTM Jobs Ontology Matching and Evaluation

This chapter presents the second key aspect of the thesis. It provides a detailed discussion on the thesis approach for matching and evaluating job seekers against BTM job requirements using SWRL rules and the SAW method. It details the selection criteria, points assignment and normalization, weighting, scoring and their integration into the rules and ontology for systematic matching and evaluation of the job seekers.

Chapter 6: Results Discussion

This chapter provides a brief comparison with related studies and approaches. It then presents and discusses the results of the ontology-based matching and evaluation technique including assessing the accuracy of the results using F-measure. Overall, the chapter addresses the research questions stated in the introduction chapter.

Chapter 7: Conclusion

This final chapter summarizes the thesis key concepts and findings indicating its significance and contributions. It also reports the thesis limitations and proposes potential future work building on the established work for further advancement and wider application scope.

In short, the thesis provides a comprehensive exploration of the potential of Semantic Web technologies to advance HRM recruitment and selection processes and offers a detailed account of the development and application of an ontology-based solution in the BTM domain.

Chapter 2

Literature Review

2.1 Human Resources Management

The concept of Human Resource Management (HRM) was initially developed in the United States in 1960s and attracted more academic attention in 1980s [4]. Furthermore, two journals of HRM were launched in 1990 namely the Human Resource Management Journal (HRMJ) and the International Journal of Human Resource Management (IJHRM). The personal management was a popular term used instead of the current term (HRM)and there has been a debate whether both terms are significantly different or not. Moreover, HRM has leveraged recent technologies including web standards and tools as an efficient and automated way of recruitment processing, hence, introducing electronic Human Resource Management (eHRM) or specifically e-Recruitment [5]. The Human Resource (HR) Open Standards Consortium[2] (non-profit global organization founded in1999) manages and develops a set of standards and specifications to promote HR related data exchanges. These standards (e.g. HR-XML and HR-JSON) define HR concepts with the aim of enhancing interoperability between HR systems. The HR open standards include several *competences schemas*, HR applications and talent management system.

Nowadays, a very large amount of information is easily accessible because of the developments in communication and IT, namely the internet. This technological development with rapidly increasing information requires managing the heterogeneity between various information sources. Therefore, managing Information and Communication Technologies (ICT) is important for any Organization to remain competitive. In this context, organizations to provide best services and accomplish the objectives, must find best ways to manage and operate their HR efficiently leveraging the advancement in ICT. The increasing importance of HRM is especially emerged by the recent economic and technological development [4]. This leads to seek better methods of eHRM or specifically e-Recruitment to keep up with the stat-of-the-art technology as well as to meet industry requirements.

HRM involves several functions that significantly impact all areas of any organization including coordinating the workforce and achieving organizational strategic goals [6]. Strategic HRM

[2] https://www.hropenstandards.org

involves ensuring that the organization's HR are in line with its future direction. It focuses on long-term issues related to people and broader concerns such as structure, quality, culture, values, commitment, and matching resources to future needs. Furthermore, globalization and international competition have transformed the business model, consequently HR strategy must adapt to these changes and synchronize with the organization's vision, mission, and goals. It should analyze the characteristics of the industry, identify competitive advantages, and recognize the importance of key processes and individuals [7].

2.2 HRM Main Functions

HRM is a central aspect of any organization and crucial for its success and growth. It involves managing staff activities, promoting an efficient and friendly working environment, and ensuring coordination between staff and management. HRM functions include planning, recruitment, selection, development, compensation, benefits, safety, health, employee relations, and HR research. These functions are key to enhancing organizations productivity [6].

This thesis focuses on the recruitment process and the selection process, highlighting their significance and challenges.

2.2.1 Recruitment Process

Recruitment plays a vital role in organizational performance as it ensures attracting the right applicants. Moreover, the recruitment process is not only crucial for finding the right candidates, but it is also necessary for the subsequent selection process. Thus, it is important to plan and manage the recruitment process using the most suitable recruitment method and expertise based on the job characteristic and the organizational goals [6] [7] [8].

Essentially, the recruitment process is the initial stage in the employment process followed by the selection process. It involves applying several steps including assessing the demand of the labor market, analyzing job requirements, creating job descriptions, and advertising job openings, which are then followed by selection steps such as evaluating candidates, conducting interviews, making job offers, and negotiating competitive salaries and benefits. These steps provide a structured and organized approach to manage the recruitment process and enable better understanding of the responsibilities and requirements of the position, as well as the overall nature of the job. Most organizations invest significantly in recruitment and staffing methods not only to identify a suitable candidate for a specific job role but also to improve their reputation and enhance their financial

performance contributing to overall organizational success [7] [9]. The following list presents the most common steps involved in the recruitment process [9]:

1- Identify the need to recruit based on factors such as vacancies and changes.
2- Update or create the job description, specification, and profile.
3- Determine the key performance areas of the recruitment planning.
4- Consult the recruitment policy and procedure.
5- Explore the sources of recruitment.
6- Choose the appropriate recruitment method.
7- Develop the recruitment advertisement strategy.
8- Advertise in the most appropriate and suitable communication medium or platform.
9- Ensure availability and sufficient time to attract a pool of potential qualified applications.
10- Screen responses.
11- Evaluate and select.

The goal is to select the most qualified individuals using the most effective method. Recruitment methods connect applicants with available positions, therefore, it's important to consider various methods and not only rely on one source. Furthermore, lack of HR planning and forecasting can lead to unclear criteria about job descriptions and the use of inappropriate recruitment methods [6]. Nowadays, organizations expand their focus beyond actual products by considering several marketing, sales, customer service, as well as employee management and retention strategies. Likewise, it is not uncommon for organizations to consider their human resources as the most valuable capital who heavily contribute to the organizations success and growth [10]. Moreover, Strategic Human Resources Planning (SHRP) focuses on aligning human resource practices with an organization's long-term strategy [11].

2.2.2 Supporting Strategic Human Resources Planning

The ontology-based recruitment approach developed in this thesis aligns with the core principles of SHRP including improving recruitment efficiency, supporting data-driven decision-making, enabling long-term workforce planning, and promoting continuous HR process improvements, as detailed in the following discussion [11] [12] [13].

Enhancing Recruitment Efficiency

A key aspect of SHRP is improving the efficiency of HR operations [11]. The developed ontology-based approach contributes to this by automating the matching and evaluation of job candidates

against requirements. This automation leverages Semantic Web technologies to ensure interoperability between diverse data models and standards and to systematically analyze both job requirements and applicant qualifications. These features can significantly reduce the time and cost of recruitment, thus allowing HR professionals to focus on more strategic tasks [12].

Data-Driven Decision Making

SHRP promotes the use of data and analytics leading to more objective and transparent hiring decisions [13]. The ontology-based approach provides structured representation and reasoning over jobs and candidates data with the support of MCDM SAW method. Moreover, the accuracy of the matching and evaluation results are verified using F-measure analysis. This ensures objectivity and transparency in recruitment decisions and aligns with SHRP principles.

Long-Term Workforce Planning

SHRP emphasizes forecasting future workforce needs and developing corresponding strategies [11]. The developed BTM ontology jobs can be easily updated as the field evolves. Furthermore, the developed matching and evaluation technique allows for flexible matching and evaluation based on requirements changes promoting long-term HR strategies in BTM field.

Continuous Improvement

SHRP requires continuous evaluation and improvement of HR practices [11]. The use of METHONTOLOGY in the developed approach ensures following best practices in ontology engineering including management, maintenance and support activities. The approach allows for managing updates of the ontology, SWRL rules, and evaluation criteria. Furthermore, it offers the potential for integration with online BTM job portals to enhance scalability and usability, thus supporting SHRP's commitment to continuous improvement.

2.2.3 Selection Process

The next phase in recruitment focuses on evaluating and selecting qualified applicants. The selection refers to the process of evaluating the qualifications of candidates and choosing the most appropriate one that matches the job requirements [8]. The process typically assesses candidates' potential performance in the role ensuring that they have the necessary qualities and are committed to remaining with the company for a reasonable duration. Hence, it is crucial to select personnel who meet the required competencies, exhibit self-motivation to succeed, demonstrate consistency, efficiency, organization and adaptability in achieving tasks, contribute effectively to the team, and show a proactive attitude towards personal growth and development [14].

The selection process includes several activities such as the following [9]:

1- Initial application screening and filtering.
2- Application forms preparation.
3- Comprehensive interviews, tests, evaluation.
4- Background check.
5- Medical examination.
6- Job offers.

The aim is to expand the organization's knowledge about an applicant's background, abilities, and motivation to facilitate informed decision-making. However, the selection process faces challenges such as interview bias, inadequate feedback, and subjective decision-making. Moreover, employers process a vast number of applications for every job offer which is a slow and costly process, especially when performed using traditional manual methods. These challenges highlight the need for a more objective and automated selections and evaluation approaches [15] [16].

2.3 Semantic Web

At present, the World Wide Web is primarily used as a document-sharing medium for people rather than a medium for manipulating information automatically. In order to transform the Web into a semantic web, the content of Web pages will be enhanced with computer-specific information, and computer-specific documents will be augmented. Computers can interpret Semantic data which is represented by hyperlinks to definitions of important terms and rules for logical reasoning [17].

Semantic Web tools and technologies[3] extend the web by giving online data a well-defined meaning that is understood and processed by machines. Thus, turning the web into a global distributed knowledge hub that can be used by applications to automate various tasks [18]. Semantic web technologies or standards among others include: Resource Description Framework (RDF) representing a model for data interchange, SPARQL query language for RDF, A JSON-based serialization for Linked Data (JSON-LD), Web Ontology Language (OWL) as a semantic web language allowing to develop ontologies with complex knowledge and their relationship that are consumed by computer programs, and Simple Knowledge Organization System (SKOS) representing a common data model for sharing and linking knowledge organization systems on the

[3] https://www.w3.org/2001/sw/wiki/Tools

Web. **Ontologies** represent semantic web key technology. Semantic web ontologies concepts are further introduced in the following section.

Sematic web includes several technologies as shown in Figure 1[4]. In this background, we focus more on the technologies closely related to the research topic such as OWL for modeling ontologies using **Protégé editor** and **Semantic Web Rule Language** (SWRL) for implementing matching rules as well as ontology engineering and ontology matching concepts in generic.

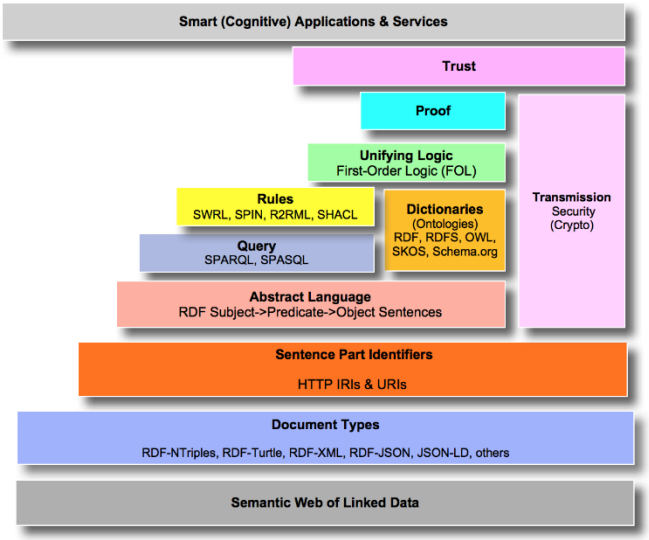

Figure 1 Semantic Web Technologies[5]

2.3.1 Ontology

The use of the term ontology originated from philosophy referring to the study of existence and the categories of objects or things [19]. Now, the term ontology is used to describe technical concepts in computer and information science domain. In this context, one of the popular ontology definitions is given as "an ontology is a formal, explicit specification of a shared conceptualization" [20]. Broadly stating, an ontology is a formal model of a real-world domain capturing and abstracting its concepts with their relationships and attributes. It allows representing both the concepts and the instances providing means of shared understanding which is a main concern when specifying information standards [16] [19]. Figure 2 [21] briefly explains the previous ontology definition.

[4] https://medium.com/openlink-software-blog/semantic-web-layer-cake-tweak-explained-6ba5c6ac3fab
[5] https://medium.com/openlink-software-blog/semantic-web-layer-cake-tweak-explained-6ba5c6ac3fab

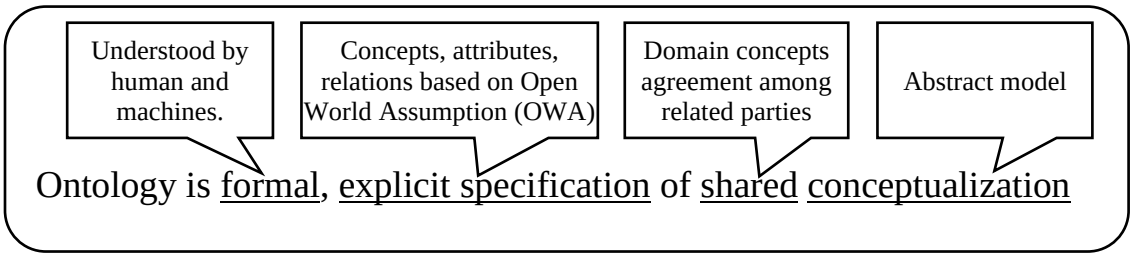

Figure 2 Ontology Definition in the Context Computer Science

Ontologies are developed using OWL to represent and model knowledge. Knowledge representation in OWL is typically depicted using five main concepts: classes, relations, attributes, axioms, and instances [22]. This modeling provides a detailed formal and semantic description of a particular problem that is agreed upon by all stakeholders [23]. In addition to formal representation of knowledge, ontologies provide advantages of reusing and sharing information [22]. Furthermore, ontologies can be used for information retrieval. Ontology-based information retrieval enhances query searching and results. Therefore, data-searching strategies can be developed using ontologies. Because ontologies provide a common vocabulary for applications, data integration issues can be addressed using ontologies [23] [24].

Ontologies are used to model knowledge in many fields including medicine, agriculture, jobs, military, the automotive industry, computer science and information systems, finances, question and answering, human perception, cloud services and recruitment [16] [22] [25] [26].

Recruitment and selection can be modeled using ontologies to identify and relate concepts and competencies of jobs requirements and applicants' qualifications such as experience, education, and skills. Ontologies enable efficient structuring, relating, reusing, and validating these concepts. Moreover, ontologies with reasoning capabilities can be used to match and evaluate applicants' qualifications based on jobs requirements [16] [22]. In addition to recruitment, competencies models have been used in several domains such as, engineering knowledge, learning, and education systems. A detailed discussion in developing and managing competencies including models and tools can be found in [26].

2.3.2 Resource Description Framework

The Resource Description Framework (RDF) is W3C standard intended for linking and representing data on the web. RDF data is represented in a triple pattern or statement consisting of subject, predicate. A Uniform Resource Identifier (URI) is used to represent RDF resources. Resources marked as blank nodes are considered anonymous resources. The URI of the predicate

indicates the relationship between the subject and the object. The subject must be a URI, while the object can be a URI, a blank node, or a literal. An RDF document is essentially a graph in which predicates are edges that connect related subjects and objects nodes. Figure 3 shows an example of RDF graph [27].

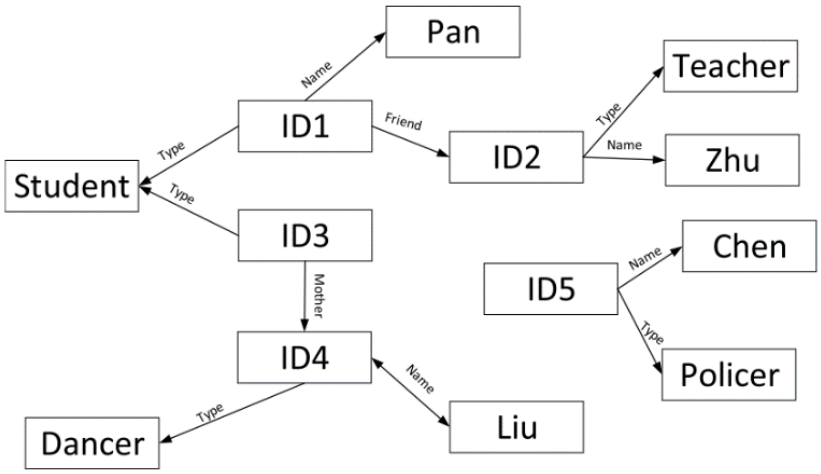

Figure 3 Directed RDF Graph [27]

RDF graphs are serialized in several syntaxes including RDF/XML, Turtle, N-Triples, N-Quads, and JSON-LD. These formats vary in their simplicity and a mount of details. The Turtle (Terse RDF Triple Language) format uses a simple and easy to read syntax. The N-Triples format provides a compact syntax that enables easy parsing and compression suitable for exchanging large amounts of linked data. N-Quads format is similar to N-Triples, but it adds a context as its fourth element to represent the source of data resulting in a format of <subject, predicate, object, context>. The JSON-LD, (JavaScript Object Notation for Linked Data) format uses JSON syntax to sterilize linked data resources [27].

The use of RDF data is constantly growing and becoming popular on the web. Such data requires employing effective management and handling techniques. Moreover, this widespread of RDF data and its management brought the attention of several communities especially the database and Semantic Web communities [28].

2.3.3 Description Logic

As a formal system used for reasoning about objects and their properties, relationships, and interactions, the First-order logic (FOL) also known as first-order predicate logic or first-order quantificational logic is highly expressive incorporating quantifiers, variables and supports

complex statements and arguments, however, FOL is not decidable [29] [30]. Decidability in reasoning refers to the ability of a reasoner to achieve inference within a finite time based on logical consequences of ontology axioms. This ensures that any ontology axioms are checked for consistency by a terminating procedure [30].

Description Logic (DL) is a decidable fragment of FOL used for knowledge or ontology modeling to represent concepts (classes), relations between them (properties), and individual instances (facts). Because it is decidable, DL is used as the base of most ontology modeling languages including OWL [30]. Moreover, DL typically models an ontology representing a knowledge base (KB) as a TBox (terminological part) and an ABox (assertional part). The TBox defines the domain structure, while the ABox describes specific instances [31]. For instance, TBox statements in a university domain may define a teacher as a person who teaches a course, and a student as a person who attends a course but does not teach. On the other hand, ABox statements define specific instances such as Mary representing a person and CS600 representing a course that Marry teaches. These statements have a formal, logic-based meaning and can be expressed in FOL as follows [31]:

$\forall x\,(\mathrm{Teacher}(x) \Leftrightarrow \mathrm{Person}(x) \wedge \exists y\,(\mathrm{teaches}(x,y) \wedge \mathrm{Course}(y)))$,
$\forall x\,(\mathrm{Student}(x) \Leftrightarrow \mathrm{Person}(x) \wedge \exists y\,(\mathrm{attends}(x,y) \wedge \mathrm{Course}(y)))$,
$\forall x\,((\exists y\,\mathrm{teaches}(x,y)) \Rightarrow \neg\mathrm{Student}(x))$,
$\mathrm{Person}(\mathrm{Mary})$,
$\mathrm{Course}(\mathrm{CS600})$,
$\mathrm{teaches}(\mathrm{Mary},\mathrm{CS600})$.

These statements can be expressed in DL as follows:

$\mathrm{Teacher} \equiv \mathrm{Person} \sqcap \exists \mathrm{teaches}.\mathrm{Course}$,
$\mathrm{Student} \equiv \mathrm{Person} \sqcap \exists \mathrm{attends}.\mathrm{Course}$,
$\exists \mathrm{attends}. \sqsubseteq \neg\,\mathrm{Student}$,
$\mathrm{Mary} : \mathrm{Person}$,
$\mathrm{CS600} : \mathrm{Course}$,
$(\mathrm{Mary},\mathrm{CS600}) : \mathrm{teaches}$.

As another example, Human concept (class) describes groups of individuals (instances) such as “Socrates” and “Plato” who share certain human characteristics, whereas relations (properties,) such as “*hasPupil*,” describe relationships between pairs of individuals, such as “*Socrates hasPupil*

Plato". In addition to atomic concepts (classes), DL also enables defining concepts by combining the atomic concepts and properties. Moreover, DL allows to assert that one concept subsumes another (is a sub class of another) or is identical to it. Given the following DL notation, for instance:

$$HappyParent \equiv Parent \sqcap \forall hasChild\,(Intelligent \sqcap Athletic)$$

The concept of $HappyParent$ is asserted as an individual who is an instance of a parent whose children's are either intelligent or athletic individuals [32].

Furthermore, DLs refer to a family of knowledge representation languages with formal semantics. The majority of DLs languages are decidable fragments of FOL. These languages were used for knowledge representation since the mid 1980s and before ontology modeling became a popular technology of the Semantic Web. Using DLs to model ontologies not only enhances knowledge representation and exchange but it also enables the use of logical deduction to infer additional information from explicitly stated facts through automated reasoning systems [33] [34].

2.3.4 Web Ontology Language

the acronym (OWL) of Web Ontology Language was proposed by Prof. Tim Finin on December 27, 2001, based on the following factors: OWL can be pronounced in a single, clear, and easily understandable way. It also expresses a good logo, conveys wisdom, and honors the One World Language project, an artificial intelligence project conducted at MIT in the middle of the 1970s. Since then, OWL's official name has been recognized [35].

Currently, OWL is the main language used to express ontologies facts in the context of the Semantic Web. It offers high expressivity that enables creating ontologies, which are developed by building hierarchies of classes that describe concepts in a domain and connecting the classes with respect to one another via properties. Moreover, OWL axioms allows to precisely define, interpret and infer ontology concepts [36].

The emergence of OWL has encouraged the creation of several reasoners, such as FacT++, Pellet, RACER, and HermiT. Likewise, OWL is the language of the popular Protégé ontology editor. OWL has quickly become the de facto standard for ontology development and data interchange in a variety of fields, including medicine, biology, geography, astronomy, defense, and the automotive and aerospace industry. Examples of OWL prominent ontologies include he National Cancer Institute Thesaurus, BioPAX, and two of NASA's SWEET ontologies [37]. A significant advantage

of OWL over RDF schemas lies in OWL abilities to express a much richer set of relationships equipped with reasoning capabilities than RDF schemas [38].

2.3.4.1 OWL Family

OWL has three variants called species: OWL Lite, OWL DL, and OWL Full. Though OWL has proven successful in many contexts, it has some expressivity limitations. Based on feedback, OWL was then updated to OWL 1.1 in September 2007 to address some of its weaknesses and also to align with recent developments in DL research [37].

The subsequent advancements in OWL 1.1 resulted in the release of OWL 2 in April 2008 [37]. Similar to OWL 1, OWL 2 has a hierarchy of sublanguages, including OWL 2 DL, OWL 2 QL, OWL 2 RL, and OWL 2 EL as illustrated in Figure 4.

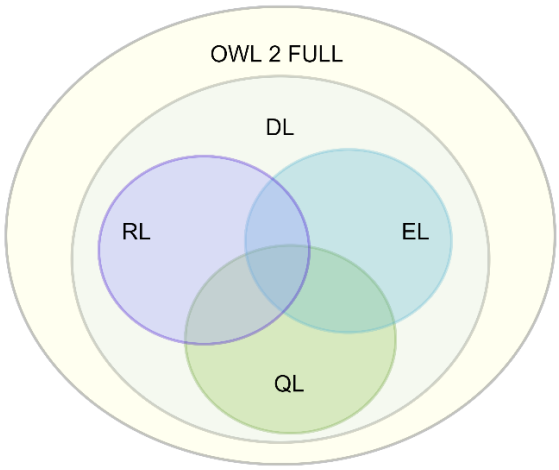

Figure 4 OWL Sublanguages [37]**.**

These OWL sublanguages are briefly explained as follows:

OWL Full uses all the primitives of OWL with maximum expressivity. It is intended to be used in cases where high expressivity is needed more than ensuring decidability. It provides the highest expressiveness of RDF without any computational assurances [39].

OWL 2 DL restricts the use of OWL and RDF constructors ensuring both high expressivity and decidability [39]. Restrictions are imposed to ensure decidability and efficient reasoning, indicating the level of expressiveness compared to FOL. These restrictions are denoted by phrases such as SHIQ, and SHOIN(D) indicating the expressive power of the modeling language. Each letter in these phrases conveys a specific meaning as follows [30]:

- *S* — indicates Attributive Language (AL) with Complement (ALC) and transitive roles. The AL serves as the fundamental language DL. It enables the utilization of various logical constructs such as Concept intersection (⋂), universal restrictions (∀), limited existential quantification (∃), and atomic negations of concepts (¬). However, it is important to note that these constructs are not present on the left-hand side of axioms. The ALC incorporates the atomic concept negation. This includes the Top concept ($\top \equiv C \cup \neg C$) and the Floor concept ($\bot \equiv C \cap \neg C$), where C represents an atomic concept. In the context of OWL, the Top concept is referred to as 'Thing' (`owl:Thing`), and all classes are subclasses of `owl:Thing`. On the other hand, the Floor concept is regarded as "Nothing" (⊥).

- *H* —refers to extending ALC with the role hierarchy (`owl:subPropertyOf` relationship).

- O —adds Nominals to ALC (enumerated classes e.g. owl:oneOf or object value restrictions such as `owl:hasValue` relationship).

- *I* — ALC is expanded by incorporating Inverse roles or properties. This extension enables the representation of relationships in opposite directions, such as `owl:hasPart` and `owl:isPartOf`.

- *N* — ALC extended with a number or cardinality restriction ($\geq$ n R.C or $\leq$ n R.C).

- *D* — enhance the representation of domain facts through the utilization of data values, datatypes, and datatype properties.

OWL 2 EL is designed as a subset of OWL 2 DL. It is especially ideal for modeling ontologies with large numbers of classes and properties. Furthermore, it enables efficient consistency check in polynomial time [39].

OWL 2 QL contains the intersection of RDFS and OWL 2 DL. It is designed to enable storing data in a typical relational database system to through an ontology using a basic query rewriting mechanism. OWL 2 QL is built on the DL-Lite family of description logics with the goal of providing comprehensive and accurate query answering in a computationally fast manner [39].

2.3.4.2 OWL Syntax

To clarify the syntax of OWL, it is helpful to explain how to use OWL to develop an ontology and define its various parts such as header, classes, properties, and relationships [39].

Header

The header of an OWL document is denoted by rdf:RDF element that defines a set of XML namespaces. The following is an example form the developed BTM Jobs ontology shows the use of rdf:RDF element:

```
<rdf:RDF
xmlns="http://www.semanticweb.org/ghebl/ontologies/2021/7/Main-btm-
ontology"
xml:base="http://www.semanticweb.org/ghebl/ontologies/2021/7/Main-btm-
ontology"
xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntax-ns#
xmlns:xml=http://www.w3.org/XML/1998/namespace
xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
xmlns:swrla=http://swrl.stanford.edu/ontologies/3.3/swrla.owl#
xmlns:ontodebug="http://ainf.aau.at/ontodebug#">
<owl:Ontology
rdf:about="http://www.semanticweb.org/ghebl/ontologies/2021/7/Main-btm-
ontology">
<ontodebug:testCase>
<rdf:Description/>
</ontodebug:testCase>
<ontodebug:testCase>
<rdf:Description/>
</ontodebug:testCase>
</owl:Ontology>
……
<rdf:RDF>
```

Following the namespace declaration, an OWL document specifies a set of assertions organized under an `owl:ontology` element and provides information about the ontology versioning:

- `owl:versionInfo`: Offers details about the current ontology.
- `owl:priorVersion`: This indicates a previous version of the present one.
- `owl:backwardCompatibleWith`: Refers to a previous version of the containing ontology that is backward compatible.
- `owl:incompatibleWith`: Indicates that the current ontology is incompatible with the referenced ontology.
- `owl:imports`: Only this assertion has a formal meaning in the ontology, and it represents a collection of different ontologies that are considered to be components of the present ontology.

Class

Classes are defined using the `owl:Class` element in an OWL document. The formal semantics of an OWL class resembles a set in FOL, and it corresponds to arity 1 predicates. For instance, the class "Teacher" can be defined as:

```
<owl:Class rdf : ID="Teacher">
      <rdfs : subClassOf rdf : resource="#Person"/>
<owl : Class >
```

The class name is defined by the rdf:ID element. The rdf:resource element is used to assign a reference to a class. The element `owl:subClassOf` in an OWL ontology is used to express the hierarchy between classes. For example, "Teacher" is a subclass of "Person." This concept is expressed in FOL, as follows:

$$\forall x \, Teacher(x) \Rightarrow Person(x)$$

Relationships between two classes can be created using owl:disjointWith and owl:equivalentCalss. For example, owl:equivalentCalss indicates that the class "faculty" is equal to the class "academicStaffMember", as follows:

```
<owl : Class rdf : ID="faculty">
      <owl : equivalentClass rdf : resource ="#academicStaffMember"/>
</ owl : Class >
```

The owl:disjointWith is applied to two classes A and B indicating that the classes are disjoint sharing no members. For example, a "Full Professor" cannot be both a "Full Professor" and an "Associate Professor" at the same time:

```
<owl:Class rdf : about="#AssociateProfessor">
      <owl:disjointWith rdf:resource="#FullProfessor"/>
</owl:Class >
```

Moreover, complex classes can be created by combining basic classes with Boolean operators (union, intersection, and complement). For instance, when the `owl:unionOf` is applied to classes A and B, it generates a new class that includes all members from the both classes. The classes "staff members" and "student" in the following example are merged to create a new class "peopleAtUni.":

```
<owl:Class rdf:ID="#peopleAtUni">
      <owl:unionOf rdf:parseType="#Collection" >
            < owl:Class rdf:about="#staffMember" / >
            < owl:Class rdf:about="#student" >
      < / owl : unionOf >
< / owl:Class >
```

Likewise, the owl:intersectionOf results in creating a new class from two classes with members that exist in the two classes:

```
<owl:intersectionOf rdf:parseType="#Collection">
      <owl:Class rdf:about="#faculty"/>
      <owl:Restriction>
            <owl:onProperty rdf:parseType="#belongsTo"/>
            <owl:hasValue rdf:resource="#CS_Department"/>
      </owl:Restriction>
</owl:intersectionOf >
</owl:Class >
```

Individuals of the new class in the above example are those who are members of both the "faculty" and the anonymous classes produced by the restriction on the property "belongsTo.".

Building on the previous example, the use of owl:complement results in choosing all of the individuals that are not members of the "staffMember" :

```
<owl:Class rdf:about="#course">
      < rdf:subClassOf >
            <owl:Class >
                  <owl:complementOf rdf:resource="#staffMember"/>
            <owl:Class >
      < rdf:subClassOf >
<owl:Class >
```

Property

Properties specify a type of relationship between class members. They are equivalent to predicates of arity 2 in FOL. Two categories of properties are identified in an OWL document:

- Object properties establish relationships between objects, such as between instances of one class and instances of another class. For example, the class "course" and the class "academicsStaffMember" are related by using the object property "isTaughtBy."

- Datatype properties connect objects to Data type values. OWL supports XML Schema data types. For instance, "http://www.w3.org/2001/XLMSchema#nonNegativeInteger" indicates a positive integer data type that can represent the age of a person.

Furthermore, applying restrictions to a property may create more complex statements that determine the subclasses of individuals who meet the specified restrictions. Restrictions types include cardinality constraints and values constraints that can be applied using owl:maxCardinality, owl:minCardinality, owl:cardinality, owl:allValuesFrom, owl:someValuesFrom, and owl:hasValues.

`owl:allValuesFrom`**:** Describes the group of individuals with values restricted to a certain class.

`owl:someValuesFrom`**:** Identifies the group of individuals that are connected to a particular class in at least one way.

`owl:hasValues`**:** Identifies a group of individuals that has same values.

Cardinality constraints indicate the number of times a property can be applied to an instance as follows:

`owl:maxCardinality`**:** Specifies the maximum number of distinct values that individuals can have for a particular property.

`owl:minCardinality`: Specifies the minimum number of distinct values that individuals can have for a particular property.

Other properties that enhance OWL expressivity include `owl:equivalentProperty`, `owl:inverseOf`, `owl:FunctionProperty`, `owl:SymmetricProperty`

`owl:equivalentProperty`: Specifies equivalent properties used in pairs of subject and object.

`owl:inverseOf`**:** States an inverse relationship between properties.

`owl:FunctionProperty`**:** Indicates that each instance can have a maximum of one value.

`owl:TransitiveProperty`: States that if a pair (x, y) satisfying a property P, and another pair (y, z) satisfying P, then the pair (x, z) also satisfies P.

`owl:SymmetricProperty`**:** Specifies that if a pair (x, y) is an instance of A, then the pair (y, x) is also an instance of A.

2.3.5 Semantic Web Rule Language

Although OWL offers straightforward and reusable, ontologies modeling, it does not support the declarative expressiveness of rules. The declarative representation of complex domain information is supported by Semantic Web Rule Language (SWRL). SWRL extends OWL with a subset of the Rule Markup Language and horn-clause rules. Over the time, SWRL is evolved to support several descriptive constructs adding enhanced expressivity to ontologies as well as powerful reasoning capabilities [30].

2.3.5.1 Semantic Web Rule Language Syntax

The syntax of SWRL extends the syntax of OWL in which a rule is composed of antecedent known as Body (B) and consequent known as Head (H). Both the B and H typically consists of conjunctions of atoms with a combination of OWL constructs:

$$atom\ B1\ \wedge\ atom\ B2\ \ldots\ \wedge\ atom\ Bn\ \rightarrow\ atom\ H1\ \wedge\ atom\ H2\ \ldots\ \wedge\ atom\ Hn$$

The constructs can be OWL classes such as C(x), object properties such as P(x, y), data properties such as Q(x, y), OWL same individuals `sameAs(x,y)`, OWL different individuals `differentFrom(x,y)`, or specific built-in functions such as `swrlb:greaterThan(?x,?y)`, where 'x' and 'y' are either variables representing OWL classes, properties, and individual data values or OWL individuals themselves [30]. SWRL offers several built-in functions including `swrlb:add` , `swrlb:multiply`, `swrlb:divide`, `swrlb:subtract`, `swrlb:equal`, and `swrlb:notEqual`.

SWRL rules offers Horn-like deductive reasoning over OWL individuals that enable the inference of new information from an existing OWL ontology. For instance, the OWL concepts of "person", "male", "sibling", and "brother" can be used to define a SWRL rule stating that a person with a male sibling has a brother as follows:

$$Person(?x)\ \wedge\ hasSibling(?x,?y)\ \wedge\ Male(?y)\ \rightarrow\ hasBrother(?x,?y)$$

Moreover, SWRL built-in functions provide effective essential features for common string and mathematical operations. For instance, the built-in `greaterThan` function can be used to check if one number is greater than another. Accordingly, using this built-in function adults can be classified by age as follows:

$$Person(?p)\wedge\ hasAge(?p,?age)\ \wedge\ swrlb{:}\ greaterThan(?age,17)\ \rightarrow\ Adult(?p)$$

Applying this rule, individuals of class `Person` with a `hasAge` property value more than 17 will be categorized as belonging to the class `Adult`.

Furthermore, SWRL rules can be used in ontologies to establish relationships between individuals. For instance, California's driving laws for minor visitors' states that a person under the age of 18 who is visiting the state for less than 10 days and has an out-of-state driver's license may be able to operate a vehicle weighing less than 26,000 pounds. This law can be expressed in SWRL as follows [36]:

```
Person(?p) ^ has_Driver_License(?p,?d) ^ issued_in_State_of(?d,?s) ^
swrlb:notEqual(?s,"CA") ^ has_Age(?p,?g) ^ swrlb:lessThan(?g,18) ^
number_of_Visiting_Days_in_CA(?p,?x) ^ swrlb:lessThan(?x,10) ^ Car(?c)
^ has_Weight_in_lbs(?c,?w) ^ swrlb:lessThan(?w,26000) →
can_Drive(?p,?c)
```

SWRL rules are semantically designed to guarantee that when the body conditions are met, the head conditions evaluates to true [30].

2.3.5.2 Semantic Web Rule Language Decidability

Although the combination of SWRL rules with ontologies provides superior reasoning advantages, it comes with the cost of undecidability. This is a consequence of SWRL high expressivity and the fact that SWRL rules are expressed in the first-order horn clause. Therefore, a constraint on the rule axioms must be imposed for SWRL to maintain decidability and achieve inferences with computational assurance. To achieve this, SWRL rules need to conform to DL-Safety principles, where variables must reference only concepts or individuals that are known to exist in the ontology. To reason over SWRL rules, moreover, reasoners such as Pellet can be used [30].

2.3.5.3 Semantic Web Rule Language Advantages

In domain knowledge modeling, rules allow efficient declarative assertions. SWRL is significant for semantic web knowledge modeling since it allows assertions of facts and retrieval of those facts. The information retrieval process is carried out with its slightly modified Semantic Web Query Language (SQWRL), which is an SQL-extended version of SWRL that queries OWL ontologies. When considering ontology modeling, one key feature of SWRL is its built-in functions. The following list presents some basic advantages of SWRL [30]:

1- The capacity to use predicates as class names or descriptions.

2- The utilization of inequalities and equalities.

3- Enabling conjunctions of atoms in both SWRL's antecedent and consequent.

4- SWRL Rules allow attributes to be transferred between classes or properties without the need for subclassing.

5- By using existential operators (e.g., swrlx: makeOWLThing), new individuals can be inferred under SWRL rules.

2.3.5.4 Semantic Web Rule Language Limitations

Despite the expressive capabilities of SWRL, an all-inclusive domain modelling language is not guaranteed. Several real-world scenarios that require, for example, knowledge retraction, fact prioritization, and knowledge exclusion cannot be accurately represented by the SWRL rules. Examples of these applications include automated ontology merging, information fusion, multimedia information processing, and alignment These applications require the use of efficient expert systems. The following list highlights some of SWRL limitations [30]:

1- SWRL is unable to capture ambiguous domain knowledge and uncertainties. As a result, SWRL has several fuzzy and probabilistic extensions.

2- SWRL does not support modeling non-monotonic facts, such as existential, quantifiers, rule exclusion, and prioritization.

3- SWRL cannot capture deductive forms of inference, in which new facts are inferred from the lack of existing facts.

4- SWRL lacks the constructs to eliminate facts from knowledge bases.

5- SWRL lacks the ability to effectively represent knowledge domains with complex mathematical formulas such as engineering, resulting often in the creation of extensive rule sets to explain a small number of facts.

2.3.6 Semantic Query-Enhanced Web Rule Language

Semantic Query-Enhanced Web Rule Language (SQWRL) is derived from SWRL. It uses SWRL rule antecedent as a pattern specification for a query. Instead of using the rule consequent, SQWRL replaces it with a retrieval specification. SQWRL defines a set of operators that enable the creation of retrieval specification. For example, `sqwrl:select` operator accepts one or more arguments and constructs a table with the arguments serving as the table's columns. To illustrate, the following query extracts individuals and their ages when the age is less than 9 [40]:

`Person(?p)^hasAge(?p,?a)^swrlb:lessThan(?a,9)→sqwrl:select(?p,?a)`

The left side of a SQWRL query operates similarly to a SWRL rule antecedent. For instance, the term "`Person` (`?p`)" not only matches OWL individuals that directly belong to the person class but also those implied by the ontology to be part of that class. Consequently, any variables that would be assigned in a SWRL rules antecedent will also be assigned in a SQWRL pattern specification.

Moreover, SQWRL `sqwrl:count` function allows for basic counting. For instance, the following query counts the number of known persons in an ontology:

`Person(?p) → sqwrl:count(?p)`

Grouped counts are also supported. For instance, the following query calculates the total number of cars possessed by each individual in an ontology:

`Person(?p) ^ hasCar(?p, ?c) → sqwrl:select(?p) ^ sqwrl:count(?c)`

SQWRL queries are tightly integrated with SWRL, consequently existing SWRL editors can be used for creating and editing SQWRL queries. Additionally, standard SWRL serialization mechanisms can be used to store queries in OWL ontologies [40].

2.3.7 SPARQL query language

SPARQL Protocol and RDF Query Language (SPARQL) is a query language designed to extract data from RDF graphs. It provides powerful graph matching capabilities based on triple patterns. When a query is evaluated, the variables within these patterns are compared against the RDF input graph. The results of this evaluation are then represented by a set of mappings, each of which connects a set of variables to graph components. Furthermore, SPARQL incorporates operators such as SELECT, AND, FILTER, OPTIONAL, and UNION enabling the creation of more complex and expressive queries [41]. Similar to SQL, SPARQL includes components such as the prefix declaration, the query part (SELECT, CONSTRUCT, ASK, DESCRIBE), the FROM part (dataset source), and the WHERE part (query pattern). The query pattern allows the use of variables denoted by a question mark to store information and connect triple patterns. Variables that do not appear in SELECT are not distinguished [27].

2.4 Multi-Criteria Decision Making

Multi-Criteria Decision Making (MCDM) methods offer a systematic and structured approach to evaluate and rank alternatives based on predefined criteria. MCDM methods are particularly powerful in addressing complex decision-making scenarios where multiple alternatives and factors need to be considered [42]. These are three stages involved in using any MCDM method [43] [44]:

1. Identifying the related criteria and alternatives.

2. Assigning numerical values to reflect the importance of the criteria and the impacts of the alternatives on these criteria.

3. Analyzing the numerical data to determine the ranking of each alternative.

2.4.1 Multi-Criteria Decision-Making Methods

MCDM methods are commonly grouped into two main categories: MADM (Multi-Attribute Decision Making) and MODM (Multi-Objective Decision Making). MADM focuses on decision-making scenarios with finite set of alternatives. Examples of MADM methods include Simple Additive Weighting (SAW), Analytic Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). On the other hand, MODM deals with decision-making situations where there are multiple conflicting objectives and infinite set of alternatives that need to be simultaneously optimized. It aims to find the best compromise solution that satisfies all the objectives to the greatest extent possible. Methods such as Goal Programming (GP) and Multi-Objective Genetic Algorithm (MOGA) are commonly used in MODM to assist decision-makers in finding optimal solutions [43] [44].

Subsequent research in MCDM resulted in developing numerous methods and related software tools. Effective use of these methods requires clear definition and analysis of the problem, alternatives, and criteria. Moreover, each method employs its own calculation approach to prioritize alternatives. It is also recognized that using different methods with the same problem input may produce different results [45].

This thesis uses the SAW method because it offers a straightforward and effective decision-making approach to evaluate jobs applicants. Moreover, the simplicity of the SAW method makes it easy to integrate with the matching SWRL rules. This combined approach aims to assess and match applicants' qualifications to job requirements by identifying and developing SWRL matching rules with integrated SAW evaluation. The SAW method is briefly introduced in the following section.

2.4.2 Simple Additive Weighting Method

Simple Additive Weighting (SAW), also known as the Weighted Sum Method (WSM) or weighted addition method, is one of the most common and simple MCDM method. The simplicity of SAW method lies in its use of weighted averages, where evaluation scores are calculated for each alternative by multiplying the scaled value of that attribute with the directly assigned weights of relative importance and then summing these products for all criteria. SAW offers the advantage of

being a proportional linear transformation of the raw data, thus preserving the relative order of magnitude of the standardized scores[43] [46] [47].

The process of using SAW method starts with normalizing the decision matrix (X) to ensure comparability across alternative ratings. The normalization is calculated using the following formula [43]:

$$r_{ij} = \frac{x_{ij}}{max_i \{x_{ij}\}}$$

Where, r_{ij} is the normalized value of alternative A_i on x_{ij} attribute for each i = 1, 2, 3, …, m and each j = 1, 2, 3, …, n and max_i is the highest value of each matrix column. The evaluation of alternative A_i is then calculated as shown on the following formula:

$$A_i = \sum_{j=1}^{n} w_i r_{ij}$$

Where, A_i is the final value of the alternative, w_i is the weight value, r_{ij} is the normalized values, and n is the number of criteria. Accordingly, the alternatives can be ranked in descending order based on A_i values where the highest A_i value represents the best alternative [43] [48]. In the context of uncertainty, several fuzzy versions of SAW are used to address decisions situations [49] [50] [42] [51] [52].

2.4.3 Multi-Criteria Decision-Making Personnel Selection Approaches

The success of businesses is greatly dependent on the effectiveness of their employees, which is influenced by a range of factors such as their skills and experience. As businesses and competition expand, effective recruitment and selection methods become vital to efficiently meet the growing needs for suitable and skilled personnel. In this context, businesses encounter several challenges in selecting the most suitable candidate from numerous applicants. Several studies address the personnel selection problem using different approaches including the use of MCDM methods [53].

The following is a review of some studies that use MCDM methods in the context of personnel selection.

Several studies compare the effectiveness of MCDM methods. For instance, Widianta et al. [54] compared TOPSIS, SAW, AHP, and PROMETHEE in the context of employee placement. Using 60 datasets, the study evaluated the effectiveness of these methods in ranking potential employees based on predetermined criteria. The results showed that TOPSIS had the highest accuracy at 95%,

followed by PROMETHEE at 93.34%, SAW at 81.67%, and AHP at 50%. Despite these overall differences in accuracy, TOPSIS and PROMETHEE produced identical results for the top 10 prospective employees. Moreover, AHP had four discrepancies in rankings, while SAW had slightly better accuracy than AHP.

Pramudito et al. [55] developed an electronic recruitment system in financing field and used Rapid Application Development (RAD) method and SAW method for recruitment decision-making. The system was created using PHP and MySQL, incorporating user input, processing functions, and various outputs to improve the recruitment process. The functional requirements of the system include user login, data handling, and report generation. The system not only enhanced the selection process objectivity, but it also significantly reduced its administrative work from one month to seven days. The authors also propose future developments including enhancing security measures, utilizing additional decision-making methods, expanding assessment criteria, and further testing the system through diagrams.

Malebye et al. [56] combined the use of SAW, TOPSIS, and WP methods for employee selection. SAW was used to select candidates, while TOPSIS and WP were used to validate the results. The selection criteria encompassed multiple attributes with varying degrees of importance or weights. The researchers conducted an empirical study to test their approach in a real-world recruitment task. The results demonstrated the validity and reliability of the employed approach.

In a similar context of personnel selection, Peiris et al. [57] used SAW and AHP to simplify scholarship candidate selection. AHP was used to establish criteria weights through pair-wise comparisons, while SAW was used to evaluate candidates based on qualifications and weighted criteria. The approach was integrated in an online system and showed 30.14% increase in efficiency, 80% reduction in manual labor, and 70% faster processing time, all of which led to reduce costs by 87% as well as increase objectivity and quality of the decision-making.

Husain et al. [47] developed a Decision Support System (DSS) for recruiting contract employees at Universitas Terbuka Mataram. The system aimed to identify the best candidates using SAW method. Developing the system involved conducting studies to identify criteria and weights for improved objective decision-making results. The results demonstrated the effectiveness of the SAW method in selecting new contract employees with accurately calculated weights, improved objectivity, reduced errors and time.

2.5 Business Technology Management

2.5.1 Overview

In 2009, industry and academia in Canada collaborated to formally establish Business Technology Management (BTM) as both an academic discipline and a recognized profession based on several national and international standards. The main vision of BTM program is to prepare leaders who can lead the digital transformation of enterprises and institutions. The BTM program reached a significant advancement in 2016 with a comprehensive update of its learning outcomes standards. Based on the identified skills and education requirements, the BTM program established specification and competencies of 27 professions. Both the brand name BTM and its French equivalent, “Gestion des technologies d'affaire” (GTA), are trademarked and reserved exclusively for accredited programs in Canada and the United States [58].

2.5.2 Business Technology Management Scop and Integration

The establishment of BTM program introduces a significant enhancement in the IS-IT profession by emphasizing and incorporating related management and business skills. This coherent blending of four streams offers flexible, collaborative, and agile approaches for digital transformation. Figure 5 illustrates the BTM scope and integration of these streams [58][59].

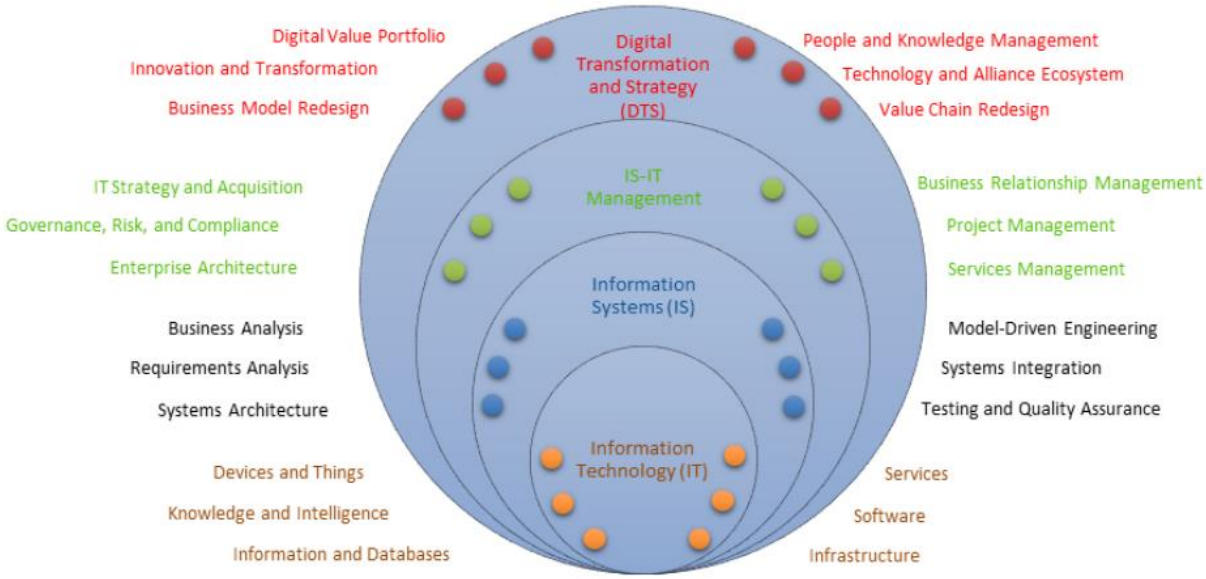

Figure 5 BTM Scope and Integration of DTS, IS-IT Management, IS, and IT [58]

2.5.3 BTM Objectives

The BTM program aims to assist IS-IT professionals in developing a cohesive skill set and facilitating seamless collaboration among all involved stakeholders. Its primary objective is to prepare the future leaders of digital transformation. The BTM vision is driven by the importance, relevance and the changing nature of IS and IT professions [60][58]:

- BTM specializations share a combination of business and technology skills.
- BTM specializations play a crucial role in leading digital transformation and offer a wide range of career paths beyond traditional roles.
- BTM specializations emphasize digital business strategies across all industries and the development of new hybrid skillsets.

The combination of these trends in the fields of IS and IT can be used to further create a coherent set of goals for the BTM profession as shown on Figure 6 [58][61].

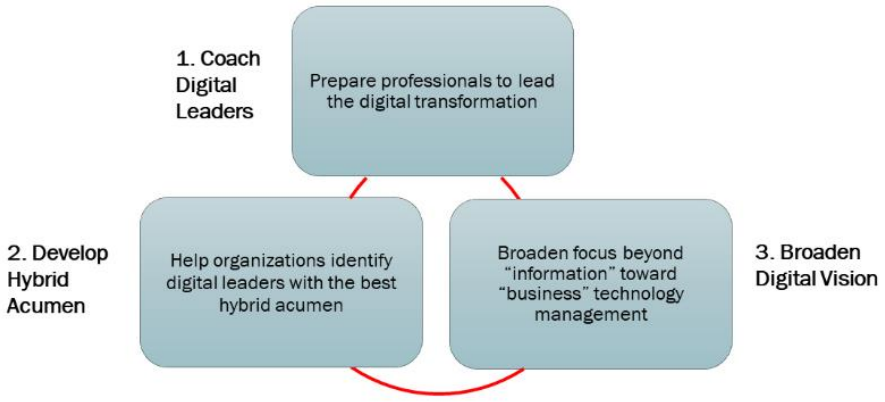

Figure 6 BTM Objectives [58]

This presents an opportunity to develop unique approaches that enhance the hybrid expertise in business-technology-management. Moreover, it encourages the exploration of different career paths and the sharing of existing practices. Additionally, these trends involve the redefinition of digital strategies, shifting the focus from information to business within the realm of IS-IT. While BTM discipline builds on the foundations of IS and IT, its scope and objectives are becoming more unified and distinct, surpassing its original disciplines [58][61].

2.5.4 Business Technology Management Profession

The BTM profession establishes smooth connections between important areas of expertise by identifying necessary skills and educational guidelines. It outlines the essential roles, fundamental competencies, effective strategies, and relevant references. Moreover, it draws upon and enhances various existing knowledge, while also offering pathways for integrating different specializations. Ultimately, it aims to offer a straightforward approach to incorporating advanced practices within the key objective of digital transformation of businesses [58].

Furthermore, the integration of business and technology skills allows to categorize and advance IS-IT jobs, as shown in Figure 7 [62].

Figure 7 IS-IT Positions Blending Business and Technology [62]

Instead of solely focusing on these positions within the IS field, the BTM profession encompasses all decision-making processes involved in establishing a digital enterprise at the organization's strategic level [62]. Additionally, BTM expands its current job roles behind undergraduate certifications by operating as a knowledge ecosystem that attempts to encompass all aspects of how professionals' advance community learning in their respective areas. Figure 8 depicts this BTM knowledge development [58].

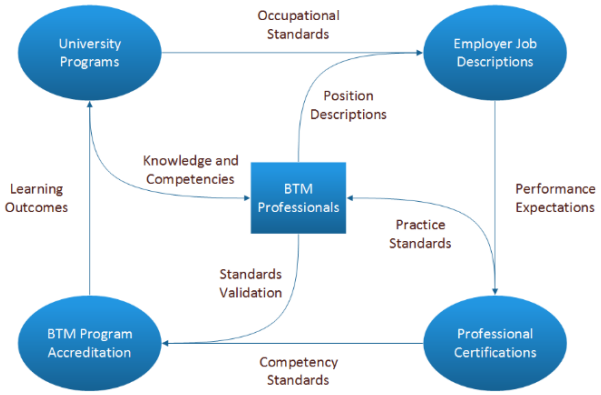

Figure 8 BTM Professionals and Community Learning Dynamics Progress

Skilled and experienced BTM professionals play a crucial role in establishing the profession. Likewise, clearly defined job roles and easily accessible competency requirements serve to further enhance the motivation to join this profession. Similarly, the job roles, position descriptions, organizational structures, and certifications linked to BTM are constantly evolving to overcome potential gaps and challenges [58].

2.5.5 Business Technology Management Progress

The BTM initiative was established in 2009 by a consortium of 10 Canadian universities and prominent IT companies. Currently, 22 business schools offer BTM programs that are accredited or formally recognized through accreditation standards resulting in 3000 of graduates in the last 5 years. Furthermore, the BTM educational standards were updated in 2016 to better align the standards with industry and professional requirements as well as to connect them with the BTM Body of Knowledge (BOK) initiative [58].

2.5.6 Business Technology Management Body of Knowledge

The BTM Body of Knowledge BOK6, serving as the fundamental reference for the BTM Forum7, is designed to function as a valuable online platform, providing guidance to professionals across different competence levels including associates, professionals, managers, entrepreneurs, and executives. In addition to knowledge and resources that are appropriate for BTM positions, the BTM BOK integrates several relevant open source libraires and standards modeled as XMI resources using Eclipse Process Framework (EPF). Moreover, the BTM BOK is intended to be open source, customizable, and reusable based on its XMI library that can be seamlessly integrated

[6] https://github.com/Digital-Innovation-Foundation/btmbok
[7] https://btmforum.org/

into various talent management systems. The BTM BOK initiative opens up opportunities for developing several applications including the creation of tailored BTM-compliant job descriptions, automated matching of CVs with job competencies, and generating personalized learning path recommendations based on acquired experience for recognized BTM careers [58].

2.6 Knowledge Modeling

Due to the numerous difficulties faced in traditional knowledge modeling, a systematic knowledge modeling approach guarantees the creation of well-structured models. Knowledge modeling enables the organization of dispersed knowledge and develops knowledge-based applications. Knowledge acquisition, knowledge representation, knowledge fusion, knowledge inference, and knowledge assessment are often part of the knowledge modelling [63] [64].

Knowledge modeling showed increased research since 1980s. Devedzic presented knowledge modeling concepts, theories, methods, systems, and applications. The knowledge modeling methods include ontology-based methods and nonontological methods. The ontology-based methods are categorized into three categories: semi-automatic, automatic, and manual. Modeling knowledge using ontologies is one of the most researched and successful approaches incorporating several principles and methodologies such as TOVE, KACTUS, METHONTOLOGY, SENSUS, and Skeletal methodology [63].

2.7 Ontology Engineering

Before the 90s, ontology development was done without clear guidelines and engineering principles. Then, ontology development became an engineering discipline named ontology engineering after substantial work on its methods, methodologies, technologies, and languages [20].

Ontology engineering refers to the set of well-defined activities along with methods, methodologies, tools, and languages all of which are used in ontology development process and life cycle. Moreover, the work in ontology engineering is evolving and improving resulting in teams and networked development as well as introducing the concept of reusing ontologies. Furthermore, ontologies play a key role in disciplines and fields such as Knowledge Management and Engineering, Artificial Intelligence, Computer Science, Natural Language Processing, E-commerce, Information Retrieval, Database Design and Integration, Bio-Informatics, Education, the Semantic Web, the Semantic Grid, and the Linked Data [20].

Ontology engineering usually requires the involvement of domain experts, ontology engineers and ontology users. It also requires identifying a proper ontology development methodology and design pattern based on a specific domain knowledge as well as the intention and the scope of the development.

The following sections give essential background on some important ontology methodologies and design patterns, especially those used in this research.

2.7.1 Ontology Development Methodologies

Ontology engineering and ontology development process is an active research area, and several studies have proposed different methodologies for building ontologies for various purposes and domains. These methodologies share similar essential ontology building activities; however, they vary in terms of supporting some activities such as ontology evaluation, maintenance, and documentation as well as in terms of reusing or building new ontologies.

In essence, an ontology methodology defines several ordered development activities and techniques as well as tools to implement and maintain the ontology [65]. Identifying the right methodology for a specific purpose is essential in ontology engineering; however, answering a question such as what is the effective methodology that can be used for developing BTM jobs ontology is not straightforward. Al-Baltah et al., [65] provided a recent comparison considering the most-known and accepted ontology development methodologies which are: Uschold and King, TOVE, METHONTOLOGY and UPON. Table 1 [65] shows a comparison of methodologies against the ontology development life cycle.

Table 1 Ontology Development Methodologies and Ontology Development Life Cycle [65]

Methodology / ***Activity***	**Uschold and King**	**TOVE**	**METHONTOLOGY**	**Brusa et al. (2008)**	**UPON**
Specification	√	√	√	√	√
Conceptualization	p	p	√	√	√
Formalization	p	√	√	p	√
Implementation	√	√	√	√	√
Maintenance	x	x	p	p	x
Knowledge-Acquisition	√	p	√	√	√
Evaluation	x	x	√	√	√
Documentation	√	x	√	√	√

* p: partially

Figure 9 shows typical phases involved in ontology development life cycle [65] [66].

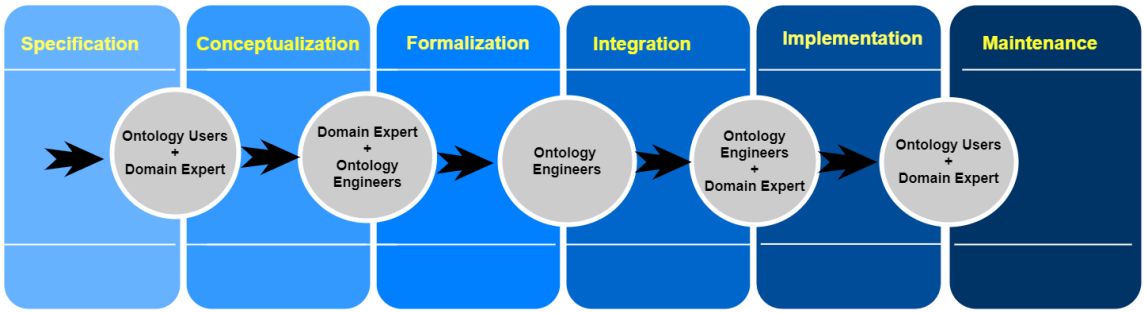

Figure 9 Typical Ontology Development Life Cycle Phases

These phases include a set of supporting activities which are Planification, Knowledge Acquisition, Documentation, and Evaluation. The ontology development life cycle phases and its supporting activities are briefly explained as follows [65] [66].

- Specification involves planification and requirements study, including determining purpose, scope, and level of formality.
- Knowledge Acquisition is the process of acquiring domain knowledge from various sources such as experts, books, documents, figures, tables, etc., in order to understand the domain and its concepts.
- Conceptualization is the process of turning the domain knowledge into indexed concepts, properties, instances, etc. METHONTOLOGY adds more flexible conceptualization separation by introducing an intermediate concepts representation that can be used in comparing different ontologies independently from the implementation.
- Formalization involves defining domain concepts and relations in a formal language such as Description Logic (DL).
- Integration is the consideration of reusing existing ontologies which may speed up development and avoids reinventing the wheel.
- Implementation is the phase in which the results of the previous phases are coded in a formal ontology language such as OWL using an editor such as Protégé.
- Maintenance is the process of updating and maintaining the ontology.
- Evaluation considers validating and verifying ontology aspects such as quality, correctness, and coverage against the specified **requirements**.
- Documentation involves documenting all activities throughout the entire development cycle.

In addition to the previous classical methodologies, NeOn Methodology is relatively new and it is based on defining several different scenarios and activities for building ontologies in a distributed

and networked team environment allowing collaborative development and dynamic evolution of ontology networks [20].

This thesis adopts METHONTOLOGY for the reasons explained in the following section:

2.7.1.1 METHONTOLOGY

Ensuring high quality design that meets all ontology life cycle development phases and activities is important. As shown on Table 1, METHONTOLOGY provides superior support for ontology development activities. METHONTOLOGY which was first introduced by Férnandez et al in 1997 focuses on ontology engineering based on ontology life cycle development unlike other methodologies which consider ontology engineering as a sub-discipline within knowledge management and acquisition [66]. Furthermore, METHONTOLOGY is compatible with software development process and knowledge engineering methodologies such as RUP (Rational Unified Process) and it allows for rapid prototyping [67]. METHONTOLOGY is mature and approved by several ontology development use cases in different domains [65].

Based on the previous discussion and justification, METHONTOLOGY is used to define BTM jobs ontology development activities. Moreover, Protégé ontology editor is used to implement and build the ontology knowledge base.

2.7.2 Protégé Ontology Editor

Protégé[8] is a remarkable ontology editor that is both free and open source. It offers strong capabilities and features for developing ontologies with advanced intelligence and structured knowledge. It has attracted users from several sectors including academia, government, and business. These diverse users use Protégé to develop complex ontologies in various fields such as biomedicine, e-commerce, and organizational modeling. Table 2 [68] compares several ontology editors' features and highlights the advantages of Protégé.

[8] https://protege.stanford.edu/

Table 2 Ontology Editors' Comparison [68]

Tools / Features	Apollo	OntoEdit	Protégé	Swoop	TopBraid Composer
Developers	KMI (Open University)	Ontoprise	SMI (Stanford University)	MND (University of Maryland)	TopQuadrant
Availability	Open source	Software license	Open Source	Open source	Software license
Semantic Web architecture	Standalone	Eclipse client/server	Standalone and Client-server	Web-based and Client-server	Standalone Eclipse plug-in
Extensibility	Plug-ins	Plug-ins	Plug-ins	Yes Via Plug-ins	Plug-ins
Backup management	No	No	No	No	Yes
Ontology storage	Files	DBMS	File DBMS (JDBC)	As HTML Models	DBMS
With other ontology tools	No	OntoAnnotate, OntoBroker, OntoMat, Semantic and Miner	PROMPT, OKBC, JESS, FaCT and Jena	No	Sesame, Jena and AllegroGraph
Imports from languages	Apollo Meta language	XML(S), OWL, Excel, RDF(S), UML2.0, database schemas (Oracle, MS-SQL, DB2,MySQL), Outlook E-mails	XML(S), RDF(S), OWL, HRML, (RDF,UML,XML)backend, text file, RDF file, Exce, BioPortal and DataMaster	OWL, XML, RDF and text format	RDFa, WOL, XML(S), RDF(S), XHTML, UML, GRDDL, RDB with D2RQ, Microdata and RDFa Web Data Sites, SPIN, Spreadsheets, Oracle database, text file, RDF file, News Feed, Email and Excel
Exports to languages	OCML and CLOS	OWL, RDF(S), RIF, SPARQL, F-Logic and Excel	XML(S), RDF(S), OWL, HTML, Java, Clips, F-Logic SWRL-IQ, Instance Selection, MetaAnalysis, OWLDoc, Queries and (RDF,UML,XML)backend	RDF(S), OIL and DAML	HTML, UML, XSD, Excel, RDB, Oracle database, RDF File, XML File and Text File
KR paradigm of knowledge model	Frames (OKBC)	Frames and First Order logic	Frames and First Order logic, SWRL and Metaclasses	OWL	RDF, OWL and SWRL
Axiom language	Unrestricted	Yes (F-Logic)	Yes (PAL)	OWL-DL	OWL-DL
Methodological support	No	Yes (Onto-Knowledge)	No	No	No
Built-in interface engine	No	Yes ontobroker	Yes (PAL)	No	WOL, SPARQL and Rule
Other attached interface engine	No	No	RACER, FACT, FACT++, F-logic and Pellet	Pellet and RDF-like	OWLIM, Pellet, Jena Rules, Oracle Rules and SPARQL Rules
Constraint/Consistency checking	No	Yes	Yes	Only with reasoner plug-in	Yes
Graphical taxonomy	No	Yes	Yes	Yes	Yes
Graphical prunes (views)	No	Yes	Yes	No	Yes
Zooms	No	Yes	Yes	No	Yes
Collaborative working	No	Yes	Yes	Yes	Yes
Ontology libraries	Yes	Yes	Yes	No	Yes

2.7.3 Ontology Design Patterns

In the context of semantic web, ontology design and development are challenging tasks. Key practices in ontology engineering are ontology development and evaluation. These practices are addressed using ontology development methodologies and Ontology Design Patterns (ODPs) which allow to build ontologies that represent the knowledge model in semantic web applications.

Similar to design patterns in software engineering, semantic web ODPs represent a modeling solution for recurring or common ontology design types and problems. In this sense, ODPs provide guidance and best practices to quickly develop high quality ontologies according to some specified requirements and intentions. Moreover, ODPs are also used to improve the quality of already existing ontologies.

In 2004, W3C initiated the work on ontology engineering practices and designated a team to study Ontology Engineering Patterns (OEP). Then in 2005, Gangemi at the Laboratory for Applied Ontology (LOA) in Rome, Italy worked on defining ODPs concepts which formed the current ODPs interpretations [69] [70] . The ontologydesignpatterns.org[9] is a semantic web portal dedicated to ODPs started under the NeOn project and run by Association for Ontology Design and Patterns (ODPA). It maintains the official catalogue of ODPs. Currently, the official catalogue defines six main ODPs groups or families that help in addressing ontology modeling and design problems. Figure 10 shows these ODPs categories based on [66] and ontologydesign.org[10].

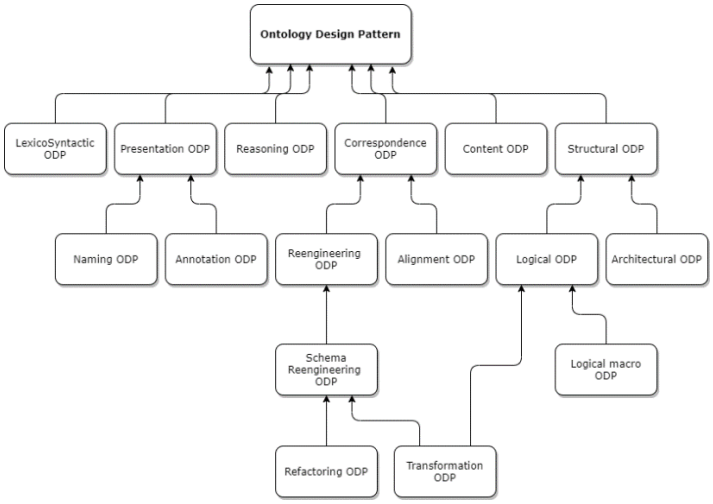

Figure 10 Ontology Design Patterns [66]

It is worthwhile mentioning that ODPs are still under development and undergoing submissions; therefore, it is a fresh research area to investigate. As stated by ontologydesignpatterns.org[11] , the current focus is on verifying and managing Content ODPs then the next step is to manage Re-engineering ODPs and Logical ODPs. The Content ODPs has the highest pattern submissions (currently 163 patterns). Ontologydesignpatterns.org portal uses a quality control mechanism to validate a pattern submission. Table 3[12] shows the current submissions of different ODPs types.

[9] http://ontologydesignpatterns.org/wiki/Main_Page
[10] http://ontologydesignpatterns.org/wiki/OPTypes
[11] http://ontologydesignpatterns.org/wiki/Odp:About
[12] http://ontologydesignpatterns.org/wiki/Community:ListPatterns

Table 3 Current ODPs Submissions Stats

	Catalogue	Submissions	All
Content ODPs	0	163	163
Reengineering ODPs	0	12	12
Alignment ODPs	0	14	14
Logical ODPs	0	18	18
Architectural ODPs	0	3	3
Lexico-Syntactic ODPs	0	20	20

The following is a brief explanation of the ODPs shown on Figure 10.

Content ODP deals with domain content problems in terms of conceptual design rather than logical design. Therefore, it is more domain dependent as it tries to specify its classes and properties that constitute an ontology.

Structural ODP addresses problems related to an ontology's overall structure and its logical concepts. It defines architectural patterns with the aim of constraining how the ontology should be structured. Logical patterns address the limitation of the underlying logic language. For instance, OWL does not support expressing n-ary relations semantics and logical patterns can be used to express such design needs.

Correspondence ODPs involve reengineering and alignment patterns where the former provides solutions of transforming ontological and non-ontological models into new ontologies whereas the latter deals with patterns that are intended for semantic matching between existing ontologies.

Reasoning ODPs are implemented as part of a reasoning engine, and they aim to provide logical reasoning and execute queries on top of an ontology. Use cases of these patterns include classification, subsumption, and inheritance.

Presentation ODPs support usability and readability of ontologies by providing annotation and naming patterns. Annotation patterns involve the use of ontology labels and comments (rdfs:lable and rdfs:comment) with classes and properties. Naming patterns are best practices for selecting ontologies namespace based on URIs and also ontologies versioning.

Lexicon-Syntactic ODPs provide natural language patterns that can be associated with logical and content patterns to allow extracting certain results about the meaning expressed in the natural language words.

There are strategies for ODP selection that help in filtering and identifying appropriate pattern for a specific ontology modeling problem based on a certain criterion. Four main filtering criteria can be identified which are filtering by domain, by requirements, by shared conceptualization and by compatibility [70].

In addition to designing and developing BTM jobs ontology, the problem of this research lays in the domain of e-recruitment with the intention of using ontology alignment and matching techniques to classify applications and match them to job offers. The ODPs that closely address this problem are alignment patterns and classification patterns. As shown on Table 3, there are 14 alignment patterns submissions which need to be studied to determine the appropriate pattern for the research problem. Since classifying applicants for jobs is essential, classification patterns can be utilized for this purpose. The classification pattern is among Content ODPs and listed for generic domains. These selected patterns are further explained in the BTM case study section.

2.7.4 Ontology Evaluation

Ontologies play a vital role in conceptualizing and structuring knowledge. The same knowledge domain can be modeled differently using ontologies. Thus, it is important to assess the design and the content of ontologies based on predefined criteria [71]. Ontology evaluation involves examining the ontologies based on two main perspectives: quality and correctness. These perspectives involve examining the following main metrics (criteria) [72] [73]:

- **Accuracy** assesses the alignment of asserted knowledge with expert understanding of the domain. A higher accuracy typically results from correct definitions and descriptions of classes, properties, and individuals.

- **Completeness** assesses whether the ontology adequately covers the domain of interest, ensuring that all relevant questions can be addressed within its scope.

- **Conciseness** examines whether irrelevant elements are included, and redundant representations of semantics are avoided, ensuring the focus on the related aspects of the domain.

- **Adaptability** measures the extent to which ontology can be easily reused across different contexts.

- **Clarity** evaluates the effectiveness of communicating the intended meaning of the defined terms. It emphasizes objective definitions independent of the context.

- **Computational efficiency** is related to the speed at which tools, such as reasoners, can operate with ontology. It assesses the ability of these tools to fulfill required tasks swiftly and effectively.

- **Consistency** ensures the absence of contradictions within the ontology.

These metrices can be categorized in terms of perspective and measure as shown in Table 4 [72]:

Table 4 Categorization of Measures for Ontology Evaluation [72]

Evaluation Perspective	Metric	Measure
Ontology Correctness	Accuracy	Precision: total number correctly found over whole knowledge defined in ontology. Recall: total correctly found over all knowledge that should be found Coverage.
	Completeness	Coverage
	Conciseness	Coverage
	Consistency	Count: Number of terms with inconsistent meaning
Ontology Quality	Computational efficiency	Size
	Adaptability	Coupling: Number of external classes referenced Cohesion: Number of Root (NoR), Number of Leaf (NoL), Average Depth of Inheritance Tree of Leaf Nodes(ADIT-LN)
	Clarity	Number of word senses

2.7.4.1 Ontology Evaluation Approaches

Ontology evaluation approaches can be grouped into main five categories: gold standard, data-driven, task-based, user-based and criteria-based [72] [71] [73] [74].

Gold Standard-Based

The Gold Standard-Based approach, also known as ontology alignment or mapping, is regarded as a direct method for ontology evaluation. This method involves comparing the learned ontology with a pre-existing reference ontology, referred to as the gold standard. The gold standard represents the ideal outcome expected from the learning algorithm. However, finding an appropriate gold standard can be challenging, as it should be developed under similar conditions and goals as the learned ontology. Some approaches address this challenge by creating specific

taxonomies with the assistance of human experts. Other approaches use reliable and popular taxonomies within a similar domain as their reference, thus reducing the required effort for establishing the gold standard [73].

Data-driven

Data-driven evaluation approaches, also known as corpus-based approaches, compare ontologies against existing data (corpus) related to the modeled domain. Using this method, various perspectives exist including classifying ontologies into topics or assessing coverage of domain concepts and relations. Data-driven techniques include text classification models, automated term extraction, vector space representation, and mapping concepts between ontologies and corpora. Compared to gold standard-based techniques, data-driven techniques are simpler to use with easier access to relevant corpora compared to ontologies. Moreover, these techniques emphasize accuracy, completeness, and conciseness. Despite these advantages, challenges remain including the dynamic nature of domain knowledge and difficulties in ensuring comprehensive coverage [72] [73].

Task-based

Task-based or Application-based evaluation approaches assesses the effectiveness of an ontology within the context of a specific application or task. This evaluation may include measuring the performance of software systems or assessing use-case scenarios. It focuses on how well an ontology improves task performance, considering factors such as relevance of search results. The results of this evaluation may detect shortcomings such as insertion, deletion, and substitution errors. The insertion errors indicate unnecessary concepts and relations. The deletion errors signify missing concepts and relations. The substitution errors indicate ambiguous concepts and relations. Given appropriate tasks, these error rates can be calculated using independent algorithms operating on the ontology. Task-based approaches challenges include difficulty in generalizing results across different application contexts and scalability issues when evaluating multiple ontologies [72] [73] [74].

User-based

User-based evaluation approaches assess how well an ontology meets predefined criteria, standards, or requirements. Unlike traditional semantic validity assessments, user-based evaluations focus on capturing subjective information about the ontology, which is deemed equally

important. This may involve gathering metadata from both ontology authors and users, including peer reviews. Additionally, users may influence evaluation metrics by assigning weights to different criteria based on their perceived importance. However, challenges include establishing objective evaluation standards and determining the appropriate users [72] [71].

Criteria-based

Criteria-based evaluation approaches assess how well an ontology or taxonomy aligns with predefined criteria or standards. These criteria can be categorized into structure-based measures and more complex, expert-based measures. Structure-based measures include properties such as average taxonomic depth, relational density, and presence of cycles in directed graphs. Complex measures incorporate multiple aspects of ontology quality, such as class match and density. Expert-based approaches, such as OntoClean, use philosophical notions to characterize ontology aspects. Criteria-based evaluation is effective in assessing ontology clarity, tool compatibility, and detecting contradictions through both simple and complex measures [73].

In addition to the above categories of evaluation, ontology evaluation approaches can be grouped based on different levels of evaluation to accommodate the complexity of ontology structures. These levels include [71]:

1- Lexical, vocabulary, or data layer: Focuses on concepts, instances, and vocabulary used in the ontology. It often involves comparisons with domain-specific data sources and the use of techniques such as string similarity measures (e.g. edit distance).
2- Hierarchy or taxonomy: Evaluates hierarchical relationships, particularly the is-a relation, which is crucial in ontologies.
3- Other semantic relations: Assesses additional relations beyond is-a, typically using measures such as precision and recall.
4- Context or application level: Considers the ontology context or application in which the ontology can be part of a larger collection of ontologies, or reference or be referenced by various definitions in these other ontologies.
5- Syntactic level: Evaluates the compliance with formal language syntax and other syntactic considerations such as the presence of natural-language documentation and avoiding loops between definitions. This evaluation level is particularly useful for ontologies that have been mostly constructed manually.

6- Structure, architecture, design: Focuses on meeting certain pre-defined design principles, criteria, structural organization, and suitability for further development. This evaluation is often used with manually constructed ontologies and performed manually.

The following Table 5 summarizes which approaches are commonly used for which of these levels.

Table 5 A Summary of Approaches Used in Ontology Evaluation [71]

Level	Evaluation Approaches			
	Golden Standard	Application-based	Data-driven	User-based
Lexical, vocabulary, concept, data	x	x	x	x
Hierarchy, taxonomy	x	x	x	x
Other semantic relations	x	x	x	x
Context, application		x		x
Syntactic	x[1]			x
Structure, architecture, design				x

[1] "Golden standard" in the context of contrasting the syntax of the ontology definition with that of the formal language (e.g., RDF, OWL, etc.) in which the ontology is written.

2.7.5 Ontology Development Approaches

Several job portals exist including popular ones such as Monster, LinkedIn and Indeed where each one uses a schema to post and structure jobs offers. Job portals require the use of multiple combined schema definitions for job postings. Most job portals are based on standards such as HR-XML or systems such as PROSPECT (a HR system for screening candidates for recruitment) [75]. Although HR-XML is a well-known standard, it does not define a unified schema for publishing job postings [67], whereas PROSPECT defines a job posting schema with concepts such as role, job category, skills, experience, location, opening, and total experience. Moreover, it focuses on candidates' selection by extracting or mining concepts from their CVs and then ranking the candidates on the bases of those extractions. However, PROSPECT relays on traditional existing job portals for CV collecting which do not define and use ontologies. Also, PROSPECT job posting schema is not comprehensive [67]. Several studies are proposing HR ontologies in generic and job description ontologies in particular including the following reviewed ones.

In e-recruitment most ontology-based approaches build upon the existing standards and classification to develop the human resource ontology. In this context, Ahmed et. al [67] proposed a job description ontology for e-recruitment domain based on PROSPECT system and Uschold and

Kings Enterprise methodology. The main design decision or pattern employed in this ontology is based on dividing the ontology into two main logical concepts which are job description and job position. The rationale behind this division is that it allows flexible reuse and multiple reposting of same jobs descriptions because frequent changes are often made on the job posting part. Moreover, the ontology evaluation method is based on data and application testing techniques given three criteria: quality, correctness, and coverage. For data testing, Schema.org positions are used as the bases and for application a custom application is built to store job descriptions based on the ontology model.

Furthermore, a comprehensive ontology for modelling HRM based on standards is proposed within the framework of the SEEMP project [76] [77] [78] [79] [80]. SEEMP which stands for Single European Employment Marketplace is a big and a long-term European Union (EU) research project with an overall budget of €4,190,131[13]. The aim of SEEMP project is to design and implement an interoperability architecture for public and private e-employment services around EU countries. It solves the problem of interoperability and heterogeneity; thus, allowing data exchange and e-employment services share among different EU member states. In essence, SEEMP is based on reusing HRM standards to build a network of semantic web enabled HRM ontologies and web services. The involved standards are: ISO 4217 for currencies, the 12 levels of driving licenses recognized by the European legislation, NACE Rev. 1.1 for economic activities, ISCO-88 (COM) and ONET taxonomy of occupations, FoET and ISCED97 for education, ISO 3166 country codes, LE FOREM classifications of contract types and work rule types, ISO 6392 for languages, and EDS classification for skills [77].

The main SEEMP Reference Ontology describes the details of a job posting and the CV of a job seeker. The Reference Ontology comprises thirteen modular ontologies: Competence, Compensation, Driving License, Economic Activity, Education, Geography, Job Offer, Job Seeker, Labour Regulatory, Language, Occupation, Skill and Time [81]. Moreover, the Reference ontology acts as a middleware ontology that provides a common language (English) for other local ontologies specific to different EU languages. Furthermore, in terms of ontologies development, the SEEMP project follows METHONTOLOGY methodology and uses WebODE ontology engineering tool [82]. The SEEMP project provides a common and unified European employment marketplace that at the same time complies with local policies of each EU country.

[13] https://cordis.europa.eu/project/id/027347

Further research based on the SEEMP project resulted in a more advanced network of ontology networks for e-employment systems where the ontologies development follow NeOn methodology [76].

To study the market demands in IT jobs, Thi et al. [83] proposed an ontology approach to analyze and extract unstructured IT job postings requirements from several job portals. The IT jobs data are extracted using a semi-automated rule-based technique. Then, the extracted data is imported into the ontology using Protégé editor. The design of the ontology is inspired by reusing and combining concepts from ESCO [84] and SARO [85] ontologies. The rule-based technique uses Stanza (NLP Python library) in two steps. First, the collected job postings requirements are fed to Stanza to extract syntactic features and named entities. Then, further extraction rules are applied to extract the instances which are then imported into the ontology. The quality and accuracy of the extraction is measured using F-measure resulting in a 0.83 average score. The expected practical use of the ontology includes career-related applications such as providing clear labor needs for job seekers and also a course recommendations system for students based on labor market demands [83]. The ontology was published[14] by Jena Fuseki Server with querying, updating, and deleting data services through SPARQL URLs Endpoints.

García-Sánchez et al. [86] developed an intelligent job portal focusing on recruitment using ontology to represent domain knowledge and enable semantic capabilities. The portal provides job search, training services, and contact tools for job seekers and companies. Moreover, they found that the use of ontology-based job portal facilitated error checking, data consistency, efficient matching between job offers and candidate profiles, and enabled rapid development. Built with JSP and MySQL with user-friendly interface, quick data input, the portal features as a central hub connecting job seekers and employers and focusing on serving the North-west region of Murcia in Spain.

2.8 Ontology Matching

The internet has made a huge amount of heterogeneous data available online. Therefore, managing vast amounts of diverse data from different resources is increasingly challenging. One solution that facilitates dealing with heterogeneity and data integration is semantic web technologies, specifically ontologies and their matching techniques. It is reported that semantic web technologies

[14] https://services.fit.hcmus.edu.vn:251/JobPostingOntology

are among the top ten disruptive technologies for 2008-2012 with around 278 papers published in the major conferences and journals during 2000-2007 [1].

Ontologies are valuable for ensuring systems interoperability by sharing and reusing knowledge across software systems. Moreover, many distributed and heterogeneous systems commonly require support from more than one ontology. Several parties, especially in semantic web area have developed different ontologies for same domains. Furthermore, different disciplines develop different ontologies according to various perspectives. All of which, thus, leads to some level of structure, concepts, entities, and relationships heterogeneity within numerous various ontologies in the same or different domains [87].

In this context, ontology matching is considered a solution to the semantic heterogeneity problem. There are ten main challenges in ontology matching, which are (1) large-scale evaluation, (2) performance of ontology-matching techniques, (3) discovering missing background knowledge, (4) uncertainty in ontology matching, (5) matcher selection and self-configuration, (6) user involvement, (7) explanation of matching results, (8) social and collaborative ontology matching, (9) alignment management including infrastructure and support, and (10) reasoning with alignments [1].

This research focuses on the alignment and reasoning challenge that emerged because of the heterogeneity problem.

2.8.1 Ontology Heterogeneity Problem

The heterogeneity problem occurs especially when considering ontologies integration and data exchange. To address the heterogeneity problem, ontology matching techniques are typically used to find corresponding and matching entities of different ontologies that have a semantic relationship [87]. In this context, ontology matching is a method of determining semantic relationships that exist between entities in different ontologies. It allows to compare those different ontologies and find similarities in terms, classes, instances, and properties. To find these similarities, ontology matching techniques allow to determine correspondences between various ontology concepts. The set of correspondences is known as alignment representing matched entities [88]. Then, the alignment can be interpreted and processed according to applications needs and purposes such as ontology merging, query answering, and data integration.

In general, there are three major categories of heterogeneities [87]:

- Syntactic heterogeneity, ontologies differ in their directories structure, relationships, or ontology languages.
- Terminological heterogeneity, the names of the same concepts in both ontologies are different.

Conceptual heterogeneity, same domain ontologies are modeled from different perspectives.

2.8.2 Ontology Matching Process

The ontology matching process takes as input two (or more) ontologies, each comprising a set of discrete entities such as (classes, properties, rules, predicates, etc.) and determines the relationships (e.g., equivalence, subsumption) as output as shown in Figure 11 [87]. The matching process can be represented as a function *f* where O1 and O2 are the ontologies, A is an optional input alignment to enhance, p is a set of parameters (weights, thresholds, etc.) and resources r, returns an alignment A′ between these ontologies [87]: A′ = *f* (O1, O2, A, p, r).

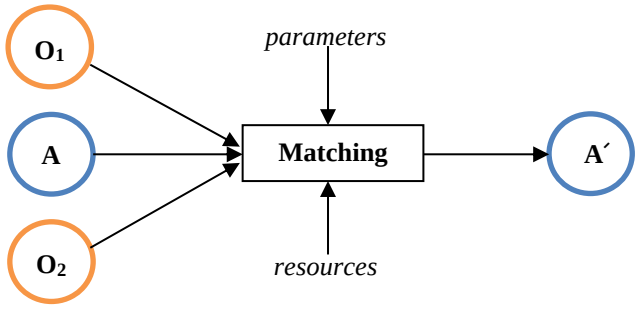

Figure 11 Ontology Matching Process [87]

2.8.3 Ontology Matching Techniques

Several ontology matching techniques have been proposed in the past decade. According to Euzenat and Shvaiko [87], the techniques are classified based on many independent factors, including:

1. **Algorithm input** type in terms of how an ontology is modeled and stored such as in RDF, OWL, or XML format and on input granularity level, for instance, concepts or instances data level and their attribute types (e.g., string, integer) and labels.

2. **Computation model** and how it interprets the input especially in terms of performance where two main models are used: approximate and exact. The exact algorithms aim to compute

precise results, whereas approximate algorithms favor performing approximate computations. Moreover, these algorithms interpret and process input data in different ways which can be categorized in three large classes: syntactic, external, and semantic based on intrinsic input, external resources, or some semantic theory, respectively.

3. **Algorithm output** or result in terms of alignment form such as one-to-one alignment between the ontology entities and whether the alignment is final or partial as well as the degree of confidence and measurement method such as distance measures. In essence, most algorithms focus on computing equivalence (≡) alignment while a few algorithms can compute more expressive results based on subsumptions (⊆) relations and contradictions (⊥) where the latter indicates no correspondences. Figure 12 [87] shows the discussed matching techniques classification.

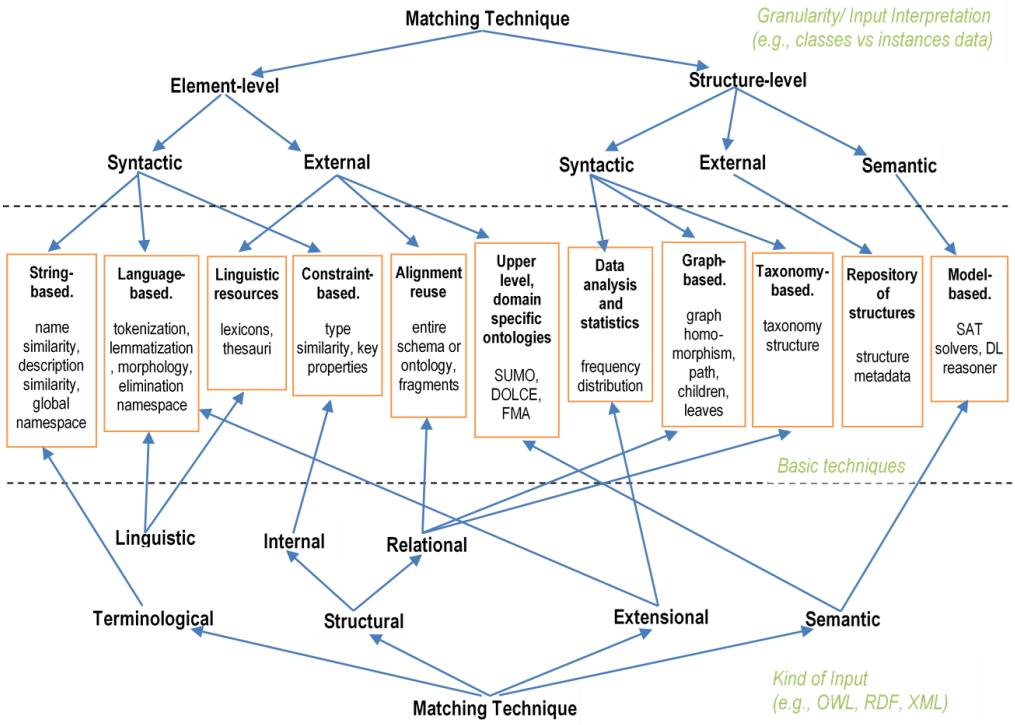

Figure 12 Ontology Matching Techniques [87]

The basic techniques, as shown in Figure 12, include string-based, language-based, linguistic resources, alignment reuse, upper-level ontologies, graph-based and model-based techniques. Furthermore, some techniques can be combined to address complex matching scenarios resulting in forming integrated matching systems [87].

Since our research aims to build a BTM jobs and CV ontology then perform corresponding matching based on semantic web technologies, ontology matching Model-based techniques specifically DL methods are of our interest. Using DL different relations can be expressed in terms of subsumptions which can be used to create the relations between classes semantically. Typically, it works by merging two ontologies, then, checking each pair of classes and properties for a subsumption to establish the matching bases [87]. Therefore, we intend to develop a DL matching model that exploits BTM jobs ontology. Then, we identify and develop SWRL[15] rules to run against the model and compute the desired matching and ranking along with the Drools[16] rule engine. Model-based techniques are deductive by nature and include methods such as propositional satisfiability (a SAT technique), model satisfiability and DL reasoning techniques. They are basically based on semantic interpretations such that if two entities (e.g., in two ontologies) are the same, then they share the same interpretations. In essence, semantic techniques operate on the bases of constructing formulas that can be used to check (un)satisfiability based on subsumption relations between two entities. The inconsistent results indicate no correspondences or alignments between the two entities [87].

2.8.4 Ontology Jobs Matching Approaches

Several studies conduct extensive reviews on ontology matching approaches and challenges including the following research.

Otero-Cerdeira et al. [89] present a comprehensive analysis of the ontology matching literature, aiming to guide new practitioners in getting general ideas about the field and also identify potential directions of research. Through an extensive literature review and classification framework, the study categorizes over 694 articles published between 2003 and 2013. This number of articles indicates a significant interest in the development of ontology matching systems. The review distinguishes between terminological, structural, and extensional matching techniques and highlights the advancement in addressing the semantic interoperability challenges across different ontology representations. Moreover, the study identifies a recurring focus on enhancing matching accuracy and efficiency, reflecting the ongoing challenges in aligning semantic representations effectively. This study provides a valuable review on ontology matching and identifies the critical areas for future research and development.

[15] https://github.com/protegeproject/swrlapi/wiki/SWRLLanguageFAQ
[16] https://github.com/protegeproject/swrlapi-drools-engine/wiki/SWRLAPI-Drools-Engine

Similarly, Shvaiko and Euzenat [90] examine the advancement of ontology matching and its significance as well as potential future challenges. Their examination shows a tangible advancement in ontology matching but with slow rate. They identify and propose solutions to critical challenges within the field. These challenges include large-scale matching evaluations, enhancing the efficiency of matching techniques, incorporating background knowledge, and optimizing matcher selection, combination, and tuning. Furthermore, they highlight the importance of user involvement, social and collaborative matching, and the development of a robust alignment infrastructure.

In the context of complex ontologies, Ochieng and Kyanda [91] conduct a comprehensive analysis of large-scale ontology matching, highlighting its significance in enhancing semantic interoperability among independently developed ontologies within similar or differing domains. This study reviews state-of-the-art techniques and tools used to address the inherent challenges in matching large ontologies. Furthermore, the paper explores scalability techniques used in matching large ontologies with limited computing resources. The study highlights strategies such as ontology partitioning, indexing, and the use of specific data structures to significantly mitigate the complexities associated with the ontology matching process. Additionally, the study investigates the effectiveness of various ontology matching tools, offering a comparative analysis of their approaches to achieve scalability and accurate matching. The paper concludes with identifying open challenges in the matching of large ontologies: Mapping Cardinality, Parallel Matching, Automatic Repair, Ontology Partitioning, and Recall.

In terms of more specific research, several studies apply ontology-based technology for matching and selection in specific domains.

In the domain of medicine, Besana et. al. [92] addressed the issue of low recruitment rates in clinical trials which is a major problem in medical research. The problem of manual matching of eligibility criteria to patient conditions combined with large number of active trials and time constraints often results in trial failures. Accordingly, the authors proposed a solution using semantic web technologies and tools. They introduced a method that uses a domain-specific ontology representing patient health record data and SWRL to verify patient eligibility for clinical trials. The developed ontology aligns with French national oncology guidelines. Unlike conventional recruitment approaches, this system prioritizes patients to enable integration with doctors' workflows. Moreover, the study used data from the Centre Hospitalier Universitaire of Rennes and emphasizes formalizing patient conditions and eligibility criteria using OWL and SWRL. The main

concept is centred around reducing the risk of ambiguity and allowing automated reasoning by matching terms from patients' records and eligibility criteria.

For diagnosing breast cancer, Oyelade et al. [93] developed a framework using ontologies and SWRL rules integrating Select and Test (ST) algorithm. Their method also attempts to address the computational efficiency issues in other methods. Results showed a 23.5% increase in accuracy with 10 patient records. The use of formal representation of patient data and domain expertise in ontologies and SWRL rules significantly contributed to this accuracy increase.

Furthermore, ontology-based technologies including SWRL are used to build enhanced and more intelligent workflow selection such as in manufacturing systems and other systems [94] [95] [96] [97] [98]. For instance, Cong-dong et al. [94] developed a framework for achieving intelligence in the working process of manufacturing systems by integrating ontology, semantic reasoning, data mining, and the Jess engine. They analyzed and constructed ontology models for workflow and manufacturing resources to establish relationships between manufacturing demand, workflow, and resources. Moreover, the reasoning process and rules for workflow generation were constructed using SWRL. This involves abstracting consumer trends and demand using SWRL and linking with manufacturing resources ontology and workflow modules. The workflow process is automatically generated through a reasoning mechanism that involves converting OWL ontology to Jess fact base and SWRL rules to Jess rule base. The SWRL BridgeAPI and Protege-OWL are used for this conversion, resulting in a new reasoning fact base that can be converted back into a new OWL ontology.

Similarly, semantic technologies are used for matching and selection in other domains such as dating [99]. Cal et al. [99] presented a Description Logic (DL) approach for dating services based on matching users profiles data under certain selection criteria. Their DL approach uses concepts of contraction and abduction inference to build a structural algorithm that uses satisfiability and subsumption in matchmaking with thresholds representing penalty functions all of which are used to determine the level of profile matching.

According to the thesis literature review, there is a lack of studies that address the issue of job-applicant matching and selection using SWRL rules. Moreover, there is no related generic and integrated solution in terms of automation, performance, accuracy and usability [1]. Most of the proposed jobs-applicants matching and selection solutions are broadly based on Description Logic (DL), machine learning, semantic ontology and a hybrid combination of these techniques [100].

DL is the underlying theory of OWL and SWRL, however, none of these approaches implement job-applicants matching and selection using OWL and SWRL rules.

Petrican et al. [100] introduced ontology-based skill-matching algorithms with a similarity metric for automatic matching in online recruitment. They developed three algorithms to match candidates and job offers incorporating fitness score for ranking the matched CVs. The algorithms define a similarity metric based on ontology paths and exhaustive search to identify the shortest path. The researchers assessed the method by using a taxonomy and manually generated data.

Shakya et. al [101] proposed CVs and jobs matching approach utilizing ESCO (European Skills, Competences, Qualifications and Occupations) ontology. They developed two metric similarity algorithms for multi-criteria matching based on skill and experience strings comparisons to find common substrings and accordingly calculates the scores.

Fazel-Zarandi and Fox [102] introduced an ontology-based hybrid approach for job recruitment, combining deductive modeling and similarity-based strategies. The deductive model determines the match between a job seeker and job posting, whereas the similarity-based approach ranks applicants. Also, the approach considers must-have and nice-to-have requirements to distinguish between hard and soft constraints. To reduce the search space, individuals satisfying at least one skill are initially identified, and then a Concept Abduction Problem (CAP) is solved to find missing skills. Furthermore, the paper emphasizes the importance of considering factors beyond advertised job requirements, such as recommendations, cultural fit, and team dynamics. Challenges in accurately assessing skills are likewise highlighted, including reliance on self-declarations and the need for valid and reliable assessments. Finally, this hybrid approach assumes balancing precision and recall and offering flexibility in job matching. The effectiveness of the approach in matching and ranking criteria is assessed empirically using an e-retail company dataset.

Hexin and Bin's [103] introduce an innovative elastic information matching technology for e-recruitment, focusing on improving the matching process by addressing the critical aspects of elastic information matching and the weighting of demand indicators. Building on the foundation of domain ontology and semantic similarity, they combine numerical matching and skill matching algorithms to handle elastic information matching and use the Analytic Hierarchy Process (AHP) to resolve weight setting issues. Skills are structured in a hierarchical tree to enable and enhance measuring similarity based on semantic distance. The study not only considers the proficiency levels of required skills but also incorporates a systematic approach to weighting various job

requirements. To validate the practicality and effectiveness of the approach, they applied the developed algorithms to a recruitment scenario represented by a graphic designer position. This research paves the way for further development of intelligent e-recruitment systems that can enhance the precision and efficiency of matching job seekers with relevant positions based on a comprehensive understanding of both hard and soft skill requirements.

Investigating ontology matching approaches in the context of eRecruitment, Hassan et al. [22] noted a common trend in utilizing established standards and classifications when developing HR ontologies that are used to represent job positions and candidates data semantically. Moreover, the study highlights the critical role of ontology matching in semantically aligning job postings with applicant profiles. The authors categorize ontology matching techniques into terminological, structural, and extensional approaches, each with its unique application in the eRecruitment domain. They also distinguish between single, networked, and newly developed ontologies, each with its strategies for enhancing the recruitment process through semantic matching. Despite the promising advancements, the authors acknowledge the challenges caused by the heterogeneity of information sources and the absence of a standardized matching technique. The conclusion emphasizes the necessity for further research to refine ontology development and matching techniques and advance the capabilities of eRecruitment systems.

Chapter 3

Methodology

3.1 Research Design

There has been a diverse debate on the nature of Information Systems (IS) research. This diversity was focused on reference disciplines, research topics, and methodologies. Recently, however, the topic of design versus behavioral science has been increasingly discussed. Most IS research tend to use design-science as a research paradigm. Yet, some researchers emphasize the importance of co-existence of both paradigms [104]. In this context, while behavioral science paradigm focuses on developing and verifying theories that study the behavioral aspects of a human or organizations, the design-science paradigm focuses on developing new software products that enhance a human or organizations abilities. The IS domain considers diverse assets such as people, organizations, and technology, therefore, both paradigms are essential in IS research where the focus on a single paradigm depends on each specific research topic [105].

3.2 Design Science Paradigm

The design science paradigm is mainly used in engineering and scientific studies especially when creating new artifacts that solve problems or extend system functionality. It allows to efficiently analyze, design, implement and manage IS with new artifacts and intellectual ideas as well as practices. These new innovations may also involve behavioral aspects [105].

This research seeks to design and develop new software artifacts with theoretical basis rooted on various related standards including ontology methodologies and matching. Therefore, this research adopts a design science research paradigm. Specifically, it follows Design Science Research Methodology (DSRM) Process Model shown on Figure 13 [106].

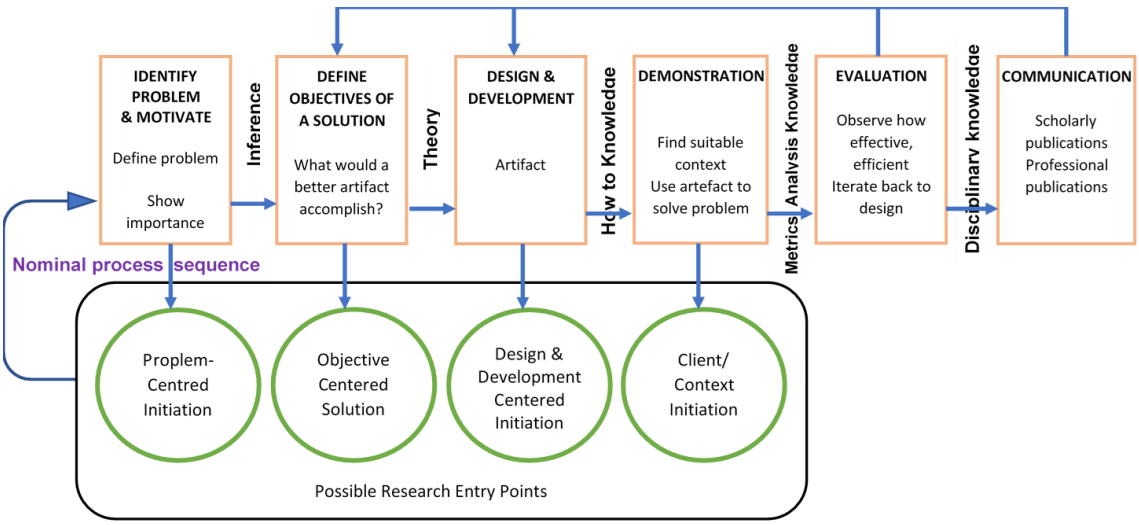

Figure 13 Design Science Research Methodology (DSRM) Process Model [106]

The introduced DSRM serves as a generic guide. Based on DSRM, the research problem, motivation, contribution, objectives, and literature review were introduced in the previous chapters. Then, the research focuses on designing and developing two main components: BTM job-applicants ontology and its corresponding matching and evaluation approach based on job requirements and applicants' qualifications. The following sections discuss the research approach in terms of data collection, design, development and evaluation of the ontology and the matching technique.

3.3 BTM Jobs Data Collection

Collecting data is a crucial part of any research. Data collection is a systematic process of obtaining information necessary for addressing research questions or solving specific research problems. There are several data collection methods and tools that are used to gather data for specific research projects. Each data collection method has its own advantages and disadvantages and selecting the right data collection method is a complex task that involves considering multiple factors and issues to minimize costs and maximize effectiveness. Data collection methods include questionnaires, interviews, observations, focus group discussions, and document analysis [107][108].

Knowledge acquisition requires gathering domain specific data. Since BTM jobs specifications are mainly available in various BTM initiative documents, this thesis uses a document analysis method to collect, categorize and analyze the BTM jobs datasets. Document analysis is an effective method for collecting data, enabling to compile and extract relevant information from written sources. The

scope of document analysis is typically limited to minimize the collection of extra and unrelated data [107].

3.4 BTM Jobs Data Analysis

BTM jobs documents use several standards to identify BTM learning outcomes and corresponding professions. The analysis of these documents revealed 27 jobs with their requirements including education, experience, and skills. These jobs are categorized in 5 categories: Data Analytics jobs, Digital Security jobs, Entrepreneurship jobs, Financial Services jobs, Health jobs. Moreover, each job details 30 to 39 requirements and specifications. Analyzing these requirements allows to identify the selection criteria that are used in the SWRL-SAW matching and evaluation approach. Figure 14 depicts a high-level view of the BTM jobs and their categories, whereas Table 6 gives an example of Digital Security Manager Officer job essential requirements that are used in the ontology development.

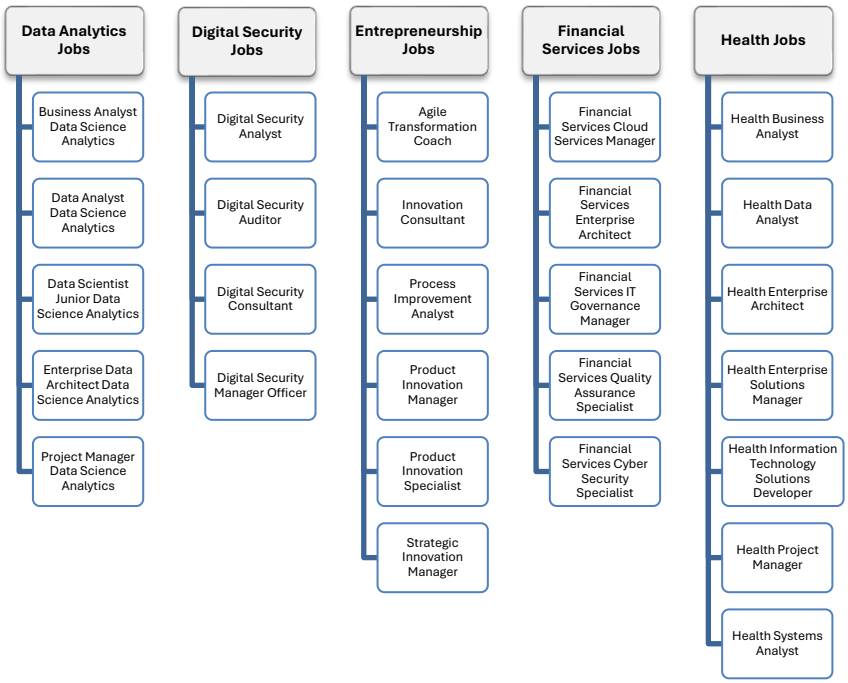

Figure 14 High-Level View of BTM Jobs and their Categories

Table 6 Example of Job Requirements Data

BTM Job Title	Digital Security Manager Officer
Education Field 1	Computer Science
Education Field 2	Statistics
Education Level 1	Bachelor
Education Level 2	None
Training 1	Management Training Courses
Training 2	None
Experience Field 1	Security Related Discipline
Experience Field 2	IT Governance Processes
Experience Level	Senior
Experience Years	7 years
Technical Skill 1	Risk Issue Management
Technical Skill 2	Software Engineering
Soft Skill 1	Working With Others
Soft Skill 2	Stress Tolerant
Language Certificate	TCF Canada
Language Certificate Level	Proficient

Moreover, the BTM jobs ontology development and matching approach introduces additional data to represent job posting details such as, ID, posted date, working shift, job type, etc. Job posting data is usually dynamic and used in job posting portals. Further, job posting data is used to identify applicants of each job by the job posting ID (e.g., Job Posting 1) and relate to jobs through Require BTM Jobs Title property. Therefore, 27 job posting examples with randomly assigned posting details are modeled in the ontology and used as part of the matching and evaluation technique. Table 7 gives an example of job posting data.

Table 7 Job Posting Data Example

Property	Data Value
Job Posting ID	**Job Posting 1**
Require BTM Jobs Title	Digital Security Manager Officer
Posted by Organization Name	Desjardins Group
Posted Date	15/02/2024
Last Apply Date	30/02/2024
Job Working Shift	Morning
Job Type	Full Time
Available Positions	5
Job Salary	$75,900.00

Equally important, the BTM jobs ontology development requires applicants' qualifications data to apply the matching and evaluation approach. Accordingly, the ontology development involves adding concepts, properties, and data values for 160 applicants with randomly assigned

qualifications. For each job, a random number of applicants are considered applied to the job through properties Apply To Job Posting and Apply To BTM Job Title. Table 8 shows an example of applicant data.

Table 8 Applicant Data Example

Job Seeker ID	**Job Seeker 1**
Name	Adam Saleem
Age	37 years
Sex	Male
Marital Status	Married
Apply To Job Posting	Job Posting 1
Apply To BTM Job Title	Digital Security Manager Officer
Education Field	Computer Science
Education Level	Bachelor
Training 1	Management Training Courses
Training 2	Nil
Experience Field 1	Enterprise Data Architect
Experience Field 2	Security Related Discipline
Experience Years	7 years
Technical Skills 1	Risk Issue Management
Technical Skills 2	Technical Problem Solving
Soft Skill 1	Working With Others
Soft Skill 2	Writing Skills
Language Certificate	TCF Canada
Language Certificate Level	Proficient

Based on the conducted literature review, METHONTOLOGY ontology development methodology is chosen to systematically analyze BTM jobs data and identify the corresponding ontology concepts and properties. Figure 15 summarizes METHONTOLOGY activities.

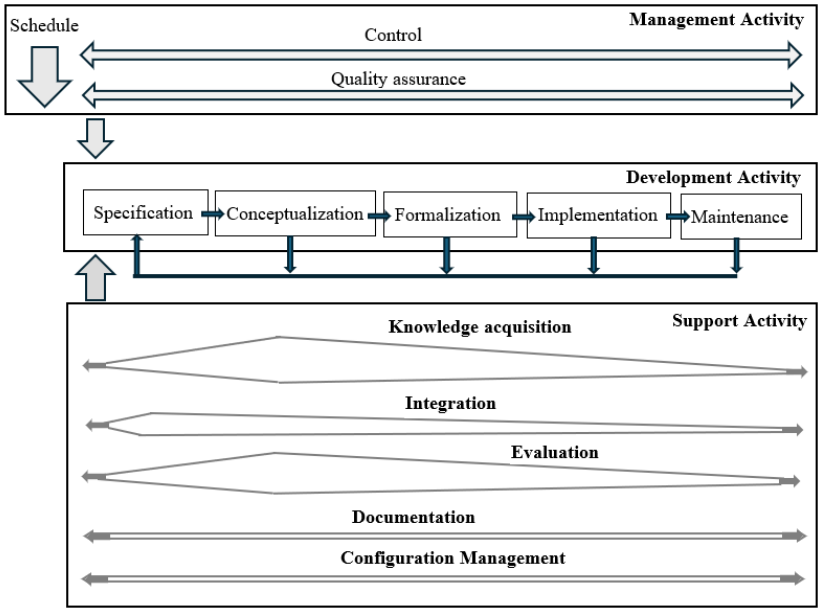

Figure 15 METHONTOLOGY Ontology Development Activities [109]

A detailed discussion of the BTM jobs data and the corresponding analysis is provided in Chapter 4. The complete data on BTM jobs requirements was extracted from the "ITAC Talent" documents, which are presented in Appendices A through E. The extracted information includes the requirements for BTM jobs details, such as educational qualifications, experience, skills, and language proficiency are found in Appendix F. Additionally, the job postings and applicants' data were generated and are available in Appendix G. All the data is imported into the ontology through Protégé editor, as explained in Chapter 6.

3.5 BTM Jobs Ontology Design and Development

Protégé ontology editor is used to design and develop the BTM jobs OWL ontology following METHONTOLOGY methodology. Figure 16 summarizes the development process.

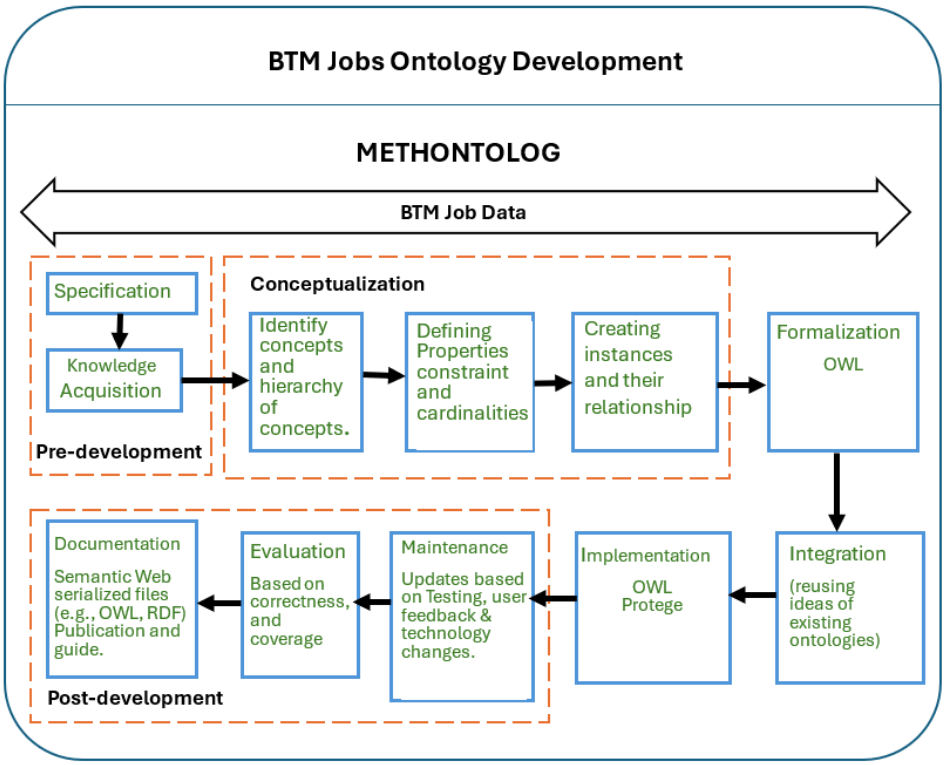

Figure 16 BTM Jobs Ontology Design and Development

Each step shown in Figure 16 is discussed in detail in Chapter 4.

3.5.1 BTM Jobs Ontology Matching

The following Figure 17 overviews the matching and evaluation approach.

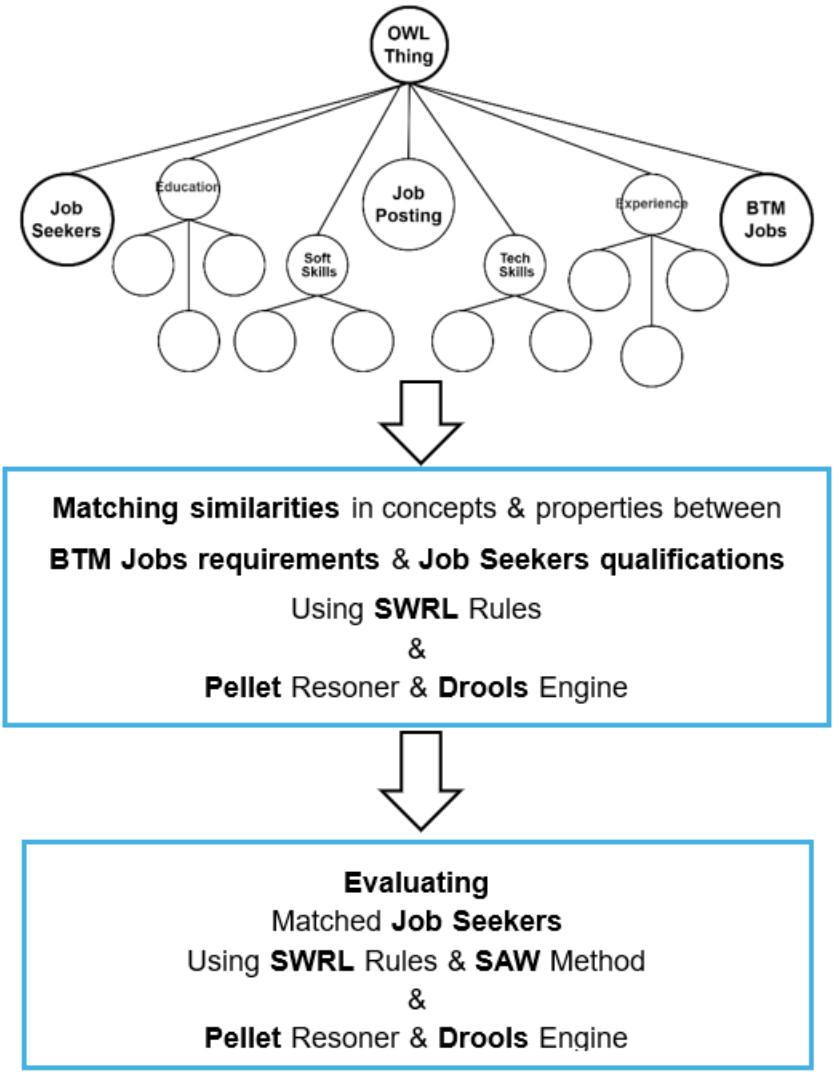

Figure 17 Matching and Evaluation Approach

The approach adopted by this research aims to use semantic web ontology technologies represented by OWL develop BTM Job and Job Seekers ontology using Protégé editor which includes reasoners such as Pellet and SWRL with Drools rule engine for rules specifying and processing. These technologies are based on DL theory featuring the development and matching model technique. Based on the concepts and structure of the developed BTM jobs ontology, relationships are identified and used to build SWRL matching rules. Moreover, the research approach uses SAW a well-known MCDM method to evaluate job seekers qualifications against BTM jobs requirements. The SAW formulas are integrated in SWRL matching rules to evaluate job seekers' qualification according to education, experience, and skills criteria.

Accordingly, 66 SWRL rules are identified and developed. These rules can be grouped into four main categories: (1) rules that assign points based on the matching criteria, (2) rules that normalize the assigned points based on SAW normalization, (3) rules that apply weights to the normalized points, (4) rules that sum up the multiplication of weights with corresponding points to calculate the final evaluation score. These rules are run in the Protégé editor using Pellet reasoner and also Drools engine providing an alternative execution method that allows saving the matching and evaluation results in the ontology. Further details are provided in the BTM Jobs Ontology Matching and Evaluation chapter as well as Results Discussion chapter.

In short, the work carried out by this research includes analyzing BTM jobs to identify ontology concepts and relations as well as job requirements to develop BTM jobs ontology with matching and selection criteria implemented on top of the ontology using SWRL rules and SAW evaluation The accuracy of the obtained matching and evaluation results are assessed using F-measure.

3.6 Results Evaluation

The matching and evaluation results are assessed using F-measure. F-measure involves the use of precision and recall concept. Precision evaluates the level of correctness of the results while recall measures the degree of completeness of the results. F-measure, then, combines the recall and precision calculation to find the single accuracy measure. F-measure enables the compensating of higher recall and lower precision or vice versa. Precision, Recall and F-measure are computed as shown on the following expressions:

$$\text{Precision} = \frac{\text{correct correspondences}}{\text{total returned correspondences}}$$

$$\text{Recall} = \frac{\text{correct correspondences}}{\text{expected correspondences}}$$

$$\text{F} - \text{measure} = \frac{2 \text{ X Precision X Recall}}{\text{Precision+Recall}}$$

The results of F-measure accuracy are presented in the Results Discussion chapter.

Chapter 4

BTM Jobs Ontology Development

The BTM Jobs ontology development is guided by METHONTOLOGY methodology. The METHONTOLOGY was developed at the Universidad Politécnica de Madrid to guide the development of ontologies from conceptualization to implementation and maintenance. It is particularly noted for its comprehensive activities that cover the entire ontology development lifecycle. METHONTOLOGY activities are categorized into three main categories: development, management, and support. First, the development activities comprise Specification, Conceptualization, Formalization, Implementation, and Evaluation. Second, management activities include Scheduling, Control, and Quality Assurance. Third, the support activities encompass Knowledge Acquisition, Integration, Evaluation, Documentation, and Configuration Management [109] [110]. The following sections discuss the core development activities and how they are applied in the development of BTM jobs-applicants ontology.

4.1 Specification

This initial activity involves defining the purpose of developing the ontology, its intended applications, and the end users. Moreover, it also involves establishing a documentation style ranging from informal to rigorously formal. Therefore, it sets the foundational goals and scope of the ontology. This seeks to develop BTM jobs-applicants ontology for the purpose of matching and evaluating the qualifications of applicants against the requirements of the jobs. Hence, the end users of the matching and evaluation systems are HRM or employers who intend to improve their hiring and section process. BTM community and closely related jobs are the direct end users since the ontology development is tailored to BTM jobs specifications and requirements.

4.1.1 Business Technology Management Jobs

There is an ongoing effort to identify and develop a comprehensive Business Technology Management Body of Knowledge (BTM BOK[17]) aiming to integrate around 57 pertinent standards, libraries, and methodologies. Based on empirical data, the integration of Business, Technology and Management domain knowledge, contribute significantly to IT and next generation organizational digital transformation [2]. Information and Communication Technologies (ICT) are important for

[17] https://github.com/Digital-Innovation-Foundation/btmbok

any Organization to remain competitive. Therefore, it is essential for all organizations to manage their ICT resources and infrastructure. BTM professional aims to integrate Business. Management, and Information Technology (IT) in a coherent specialization that allows solving business problems, developing business strategies, improve organizational processes, and performance by adapting recent and advanced technology and methodologies.

BTM[18] as a multi-discipline field of study was initiated in Canada in 2009 aiming to support industry's demands for professional graduates' leaders equipped with the right skills of both business and technology and meeting rapidly changing advanced technology requirements. Several Canadian universities[19] have adopted and offered BTM study programs and thousands of students have graduated from BTM discipline with increasing rate of enrollment.

BTM specification defines Learning Outcomes and Competency Standards based on related national and international standards and the work with academic institutions, industry, and sector associations. In particular, the used standards are the Skills Framework for Information Age (SFIA), National Occupational Standards (NOS) by the Management Standards Center's (MSC), and the Bloom's Taxonomy. Table 9 summarizes the main concepts and components of the BTM program.

Table 9 BTM Program Main Concepts and Components

BTM main concepts and components	
BTM program purpose	Prepare organizations to true digital transformation with leaders equipped with latest technology and knowledge enhancing organizational strategical plans
Professionalize the BTM sector	Standardization, accreditation, education, certification, career paths
Knowledge areas	(1) Integrative, (2) Personal & interpersonal, (3) Business, (4) Technology, (5) Technology in business, (6) Processes, projects, change
National Occupational Standards	Framework for professional education and career development
Number of BTM programs	Over 20 university programs across Canada
Latest Specification Version	2016
Organization	ITAC, then TECHNATION and independent currently
Profession Role Set	Analyst, Architect, Manager
Number of Roles or jobs	27
Target Profession	Financial Services, Digital Health, Data Analytics, Digital Security, Entrepreneurship, and Innovation, *Interactive Communications
Learning Outcomes (LO)	Based on SFIA Levels 4,5,6 and customized Bloom's Taxonomy
BTM learning outcomes Bloom's taxonomy levels	(1) Remembering & understanding, (2) Applying, (3) Analyzing & Evaluating, (4) Creating
Number of LO	70
Education programs	BTM Baccalaureate, BTM Master
Certification types	Certified Associate, Certified Professional, Certified Executive
* Under development	

[18] https://btmforum.org/about/
[19] https://cips.ca/BTM/

This research operates on BTM jobs specifications and requirements to develop job-applicants OWL ontology with matching and evaluation technique implemented using SWRL rules and MCDM represented by SAW method.

4.2 Knowledge Acquisition

In the process of developing an ontology, this activity focuses on collecting necessary domain knowledge through various techniques such as interviews, literature reviews, and analyses of relevant documents and existing ontologies to better understand the domain and its concepts. In most cases, knowledge acquisition activity is aligned with the specification activity, and it decreases with the subsequent activities. It allows to improve the glossary of terms and their meaning. [110].

The following subsections discuss the BTM jobs knowledge, identifying the glossary of terms and their meaning.

4.2.1 Business Technology Management Jobs Analysis

The first step in developing a knowledge representation system involves conducting a comprehensive analysis of the domain to identify and clarify terms and associated properties and attributes. This analysis results in classifying domain-specific terms and determining the relationships among them. Such knowledge representation can be shared and reused for similar requirements and domains.

In addition to reviewing related studies referenced in [2] [3] [58] [62] [111] and jobs portals such as LinkedIn and Indeed, the BTM jobs analysis is mainly based on reviewing and analyzing relevant documents. BTM jobs are grouped into 3 main role sets (Analyst, Architect, Manager) and 5 major target professions (Financial Services, Digital Health, Data Analytics, Digital Security, Entrepreneurship, and Innovation). Table 10 gives the number of jobs (positions) in each target profession.

Table 10 Number of BTM Jobs with their Corresponding Target Profession

Job Category / **Role Set**	**Finance**	**Health**	**Data Analyst**	**Digital Security**	**Entrepreneurship**
Manager	2	2	1	1	2
Architect	2	2	1	2	3
Analyst	1	3	3	1	1
Sub -Total	5	7	5	4	6
Total	27				

Moreover, each job has 30 to 39 specifications including jobs descriptions, education, experience and skills requirements. Figure 18 shows an example of a BTM job representing Financial Services Enterprise Architect with its 34 fields excluding their text content.

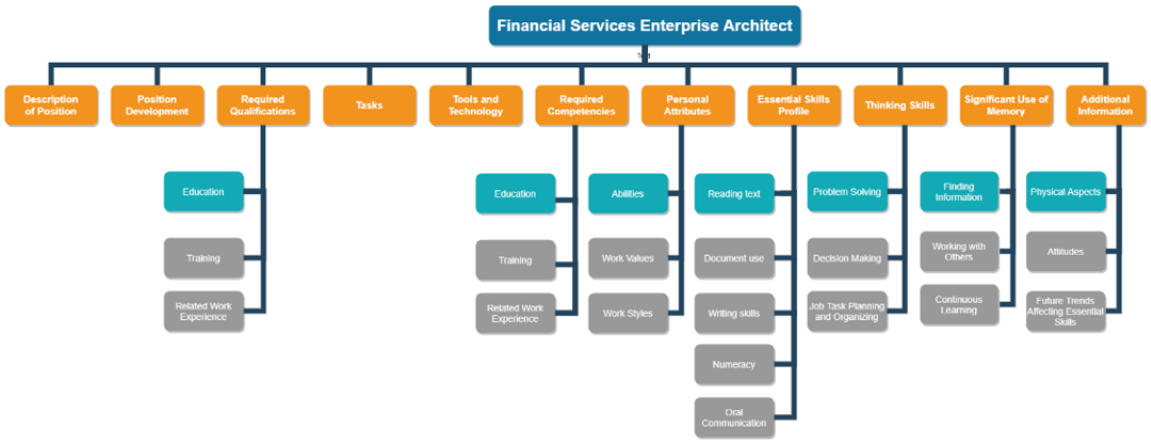

Figure 18 BTM Job Example: Financial Services Enterprise Architect

4.3 Conceptualization

In a conceptualization activity, the informal understanding of the domain knowledge is organized into a structured conceptual model defining a comprehensive glossary of terms and the classification of concepts and their interrelationships. This is achieved using a variety of intermediate representations (IRs), such as tables and graphs. The conceptualization process involves the following main tasks:

1- Glossary Development: Defines all relevant terms such as Education, Experience, Technical Skills, Soft Skills, etc., along with their descriptions and synonyms.

2- Concept Taxonomy Creation: Organizes concepts into a hierarchical structure, for instance, distinguishing between different types of Skills, Technical or Soft Skills.

3- Relation Mapping: Establishes relationships between concepts, such as “has soft skill” linking Applicant to Skill.

4- Attribute Specification: Defines attributes for each concept, such as specifying “years of experience” for a Job.

5- Instance Identification: Defines instances of each concept, such as specific job position (Data Analyst).

These tasks are detailed in the following discussion.

4.3.1 Task 1: Developing the glossary of terms

A glossary encompasses all relevant terms (concepts, instances, attributes, and relation). During the early stages of ontology conceptualization, several terms could refer to the same component in the glossary. Table 11 shows part of the developed BTM Jobs glossary of terms.

Table 11 Glossary of Terms of BTM Jobs Entity Ontology

Name	Description	Type
BTM Jobs Title	Title of BTM Jobs	Concept
Education	Education filed, degree level or Training	Concept
Education Field	Education field	Concept
Education Degree Level	Education degree level	Concept
Training Certificate	Education training certificate	Concept
Experience	Experience field, level or time	Concept
Experience Field	Experience field	Concept
Experience Level	Experience level	Concept
Experience Time	Experience time	Concept
Skills	Skills either technical or soft	Concept
Soft Skills	Soft skills	Concept
Tech Skills	Technical skills	Concept
Job Posting	Job posting	Concept
Job Seeker	Job seeker	Concept
Language	Language certificate	Concept
Language certificate code	Language certificate code	Concept
Language Certificate Name	Language certificate name	Concept
Language Certificate Level	Language certificate level	Concept
Location	Location	Concept
Continent	Continent	Concept
Country	Country	Concept
Province	Province	Concept
City	City	Concept
Organization	Organization name	Concept
Matched Jobs	The matched jobs	Concept
Ranked Jobs	The ranked jobs	Concept
Apply To BTM Job Title	Job Seeker, BTM Jobs Title	Relation
Apply To Job Posting	Job Seeker, Job Posting	Relation
Has Education Field	Job Seeker, Education Field	Relation
Has Education Level	Job Seeker, Education Degree Level	Relation
Has Experience Field1	Job Seeker, Experience Field	Relation
Has Experience Field2	Job Seeker, Experience Field	Relation
Has Experience Time	Job Seeker, Experience Time	Relation
Has Language Certificate Code	Job Seeker, Language Certificate Code	Relation
Has Language Certificate Level	Job Seeker, Language Certificate Level	Relation
Has Soft Skills 1	Job Seeker, Soft Skills 1	Relation
Has Soft Skills 2	Job Seeker, Soft Skills 2	Relation
has Technical Skill 1	Job Seeker, Technical Skill 1	Relation
has Technical Skill 2	Job Seeker, Technical Skill 2	Relation
Has Training 1	Job Seeker, Training Certificate	Relation
Has Training 2	Job Seeker, Training Certificate	Relation
Located In	Job Seeker and Organization, Location	Relation
Posted By Organization	Job Posting, Organization	Relation
Require BTM Jobs Title	Job Posting, BTM Jobs Title	Relation
Require Education Field 1	BTM Jobs Title, Education Field 1	Relation
Require Education Field 2	BTM Jobs Title, Education Field 2	Relation
Require Education Level 1	BTM Jobs Title, Education Degree Level 1	Relation

Name	Description	Type
Require Education Level 2	BTM Jobs Title, Education Degree Level 2	Relation
Require Exp Field1	BTM Jobs Title, Experience Field 1	Relation
requireExpField2	BTM Jobs Title, Experience Field 2	Relation
Require Exp Time	BTM Jobs Title, Experience Time	Relation
Require Language Certificate Code	BTM Jobs Title, Language Certificate Code	Relation
Require Language Certificate Level	BTM Jobs Title, Language Certificate Level	Relation
Require Soft Skill 1	BTM Jobs Title, Soft Skills 1	Relation
Require Soft Skill 2	BTM Jobs Title, Soft Skills 2	Relation
Require Technical Skill 1	BTM Jobs Title, Technical Skill 1	Relation
Require Technical Skill 2	BTM Jobs Title, Technical Skills 2	Relation
Require Training 1	BTM Jobs Title, Training Certificate 1	Relation
Require Training 2	BTM Jobs Title, Training Certificate 2	Relation
Has Name	Job Seeker	Instance Attribute
Has Age	Job Seeker	Instance Attribute
Has Sex	Job Seeker	Instance Attribute
Has Marital Status	Job Seeker	Instance Attribute
Job Posted Number	Job Posting	Instance Attribute
Has Available Positions	Job Posting	Instance Attribute
Has Job Posted Date	Job Posting	Instance Attribute
Has Last Apply Date	Job Posting	Instance Attribute
Has Job Salary	Job Posting	Instance Attribute
Has Job Type	Job Posting	Instance Attribute
Has Job Working Shift	Job Posting	Instance Attribute

4.3.2 Task 2: Creating concept taxonomies

To define concept hierarchy, the ontologist builds concept taxonomies based on the glossary of terms. METHONTOLOGY suggests utilizing four taxonomic relations: Subclass-Of, Disjoint-Decomposition, Exhaustive-Decomposition, and Partition [112].

Subclass-Of a concept indicates that if every instance of concept (C1) is also an instance of concept (C2). To illustrate, the concept of Soft Skill 1 is a subclass of the parent Soft Skills class since every soft skill 1 can be categorized as a soft skill. Moreover, it is possible for a concept to hold subclass relationships with multiple other concepts.

A Disjoint-Decomposition of a concept C is a set of subclasses of C that do not share instances and do not cover C. For example, the concepts of Education Field and Education Level are a disjoint decomposition of the concept Education because no instance of education field can be at the same time instance of education level and vise versa. Furthermore, there may be instances of the concept skill that are not instances of any of the two classes.

An Exhaustive-Decomposition of a concept C is a set of subclasses of C that cover C and may have common instances and subclasses indicating that there cannot be instances of the concept C that are not instances of at least one of the concepts in the decomposition.

A Partition of a concept C is a set of subclasses of C that do not share common instances and that cover C implying that there are not instances of C that are not instances of one of the concepts in the partition.

After organizing the concepts within the concept taxonomy, it is essential to review the taxonomies for any possible errors. For instance, it becomes necessary to verify that an element does not belong to two classes simultaneously within a disjoint decomposition, to ensure the absence of loops within the concept taxonomy, and to confirm that multiple terms do not refer to a single concept, among other considerations.

Figure 19 shows the structuring of certain concepts in the BTM Jobs ontology. For instance, “Education” has subclasses such as Edu Field1”, “Edu Field2”, “Edu Level”. These are organized as a disjoint decomposition, ensuring that instances of “Edu Field1” do not overlap with instances of its Edu Level or the parent “Education” class. This organization helps maintain clarity and separation between different aspects of education within the ontology.

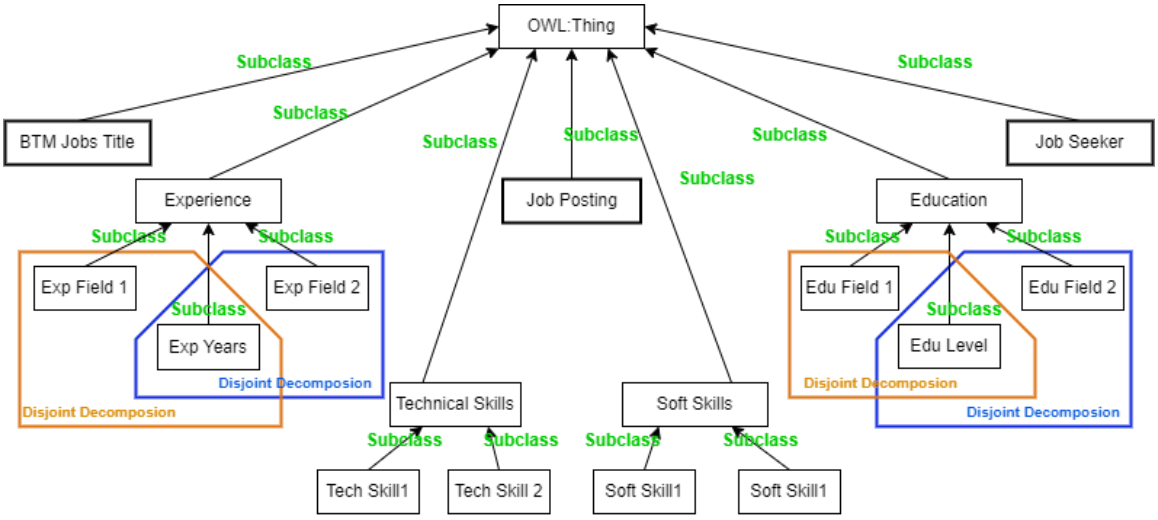

Figure 19 BTM Jobs Ontology Main Concepts Structure

Once the taxonomy has been built and evaluated, the conceptualization activity involves creating associations such as ad hoc binary relation. The aim is to establish ad hoc connections between concepts belonging to the same (or distinct) concept taxonomy.

A portion of BTM jobs ontology ad hoc binary relations is shown in Figure 20.

Figure 20 BTM Jobs Ontology Ad hoc Binary Relations

The inverse relationship between a Job Seeker concept and a Job Posting concept is represented by "Apply to Job Posting" and "Has Applicant" ad hoc binary relation.

4.3.3 Task 3: Build concept dictionary

Following the creation of the concept taxonomies and ad hoc binary relation of the BTM Jobs Ontology, the properties, relations, and instances are defined to compose the concept dictionary. Table 12 presents a portion of the BTM Jobs ontology's concept dictionary.

Table 12 Portion of the BTM Jobs Ontology's Concept Dictionary

Concept Name	Instances	Instance attributes	Relation
BTM Job Title	Business Analyst Data Science & Analytics Digital Security Manager Officer Financial Services Enterprise Architect …		Require Education Field Require Experience Years Require Soft Skills …
Job Seeker	Job Seeker 1 Job Seeker 2 Job Seeker 3 … JSeeker160	Has Name Has Age Has Sex …	Apply To BTM Job Title Has Technical Skills Has Education Level …
Job Posting	Job Posting 1 Job Posting 2 … Job Posting 27	Has Available Positions Posted By Organization Job Type …	Posted By Organization Require BTM Jobs Title Has Applicant …

4.3.4 Task 4: Define instance attributes

BTM Jobs ontology concept dictionary defines all the instance attributes (data property) in a table where each row represents a full explanation of a certain instance attribute. An example of instance attributes is shown in Table 13.

Table 13 BTM Jobs Ontology Instance Attribute

Instance attributes Name	Concept Name	Value Type	Value Range
Has Marital Status Has Education Level Has Age …	Job Seeker	String String Integer	{Married, Single} {Diploma, Bachelor, Masters, Doctorate}

Instance attributes Name	Concept Name	Value Type	Value Range
Has Job Type Job Working Shift Offer Job Salary …	Job Posting	String String Decimal …	{Full Time, Part Time} {Morning, Evening}

These instance properties help to distinguish between the different instances of the concepts. The following list explains these instance attributes:

1. Name: The name of the instance attribute.
2. Value Type: The data type that the attribute's value belongs to (e.g., text, number, date, etc.).
3. Value Range: Determines a certain rang of values when applicable.

4.3.5 Task 5: Define instances

When the conceptual model of the ontology is created, relevant instances in the concept dictionary are defined in an instance table. The table includes details for each instance such as its name, the concept to which it belongs, and any attribute values it has [112]. As the conceptual model for the BTM Jobs ontology has been created, the corresponding instances are defined in the instance table as shown in the examples in the following Table 14.

Table 14 Portion Instance of BTM Jobs Ontology

Instance name	Concept name
Digital Security Auditor	BTM Jobs Title
Computer Science	Education Field
Doctorate Degree	Education Degree Level
Certified Product Manager	Training Certificate
Designing Customer Solutions	Experience Field
Executive	Experience Level
IELTS	Language Certificate Code
Proficient	Language Certificate Level
Test D'évaluation De Français	Lang Certificate Name
Complex Data Analytics	Technical Skills
Document Use	Soft Skills
Desjardins Group	Organization
North America	Continent
Canada	Country
Gatineau	City
Job Posting 1	Job Posting
Job Seeker 1	Job Seeker

Then, following METHONTOLOGY practice, formal axioms and rules are described based on the defined concepts and their taxonomies, relations, attributes, instance, [112].

4.4 Formalization

Formalization activity transforms the semi-formal model into a formalized or semi-computable model using a formal language, such as Description Logic (DL) or first order logic. This activity lays the groundwork for the next implementation activity. Thus, it is essential to identify and describe the ontology's formal axioms. For each formal definition of an axiom, METHONTOLOGY recommends specifying the following information: name, description, and logical expression. The logical expression uses a formal language to define the axiom incorporating concepts, attributes, relations, and variables [112]. Examples of formal axioms defined BTM Jobs are shown in Table 15.

Table 15 Portion of Formal Axiom Table of BTM Job Ontology Axiom

Description	Expression	Referred concepts	Referred relations	Variables
Job posting requires jobs title	JobPosting(?X) and BTMJobsTitle(?Y) and requireJobsTitle (?X, ?Y)	JobPosting BTMJobsTitle	requireBTMJobsTitle	X Y
Job seekers apply to job posting	JobSeeker(?Z) and JobPosting(?X) and applyToJobPosting(?Z, ?X)	JobSeeker JobPosting	applyToJobPosting	Z X
Job seekers apply to BTM jobS title	JobSeeker(?Z) and BTMJobsTitle(?Y) and applyToJobsTitle(?Z, ?Y)	JobSeeker BTMJobsTitle	applyToBTMJobsTitle	Z Y

As indicated in Table 15, for instance, the BTM Jobs ontology describes "job postings require BTM jobs titles" axiom that is expressed as JobPosting(?X) and BTMJobsTitle(?Y) and requireJobsTitle (?X, ?Y). the referenced concepts and relations in this axiom are shown in the respective columns in Table 15 . The variable (?X) refers to the instance of the Jobposting concept, and (?Y) refers to the instance of the BTMJobsTitle concept. Similarly, the "Job seekers apply to job posting" is expressed as JobSeeker(?Z) and JobPosting(?X) and applyToJobPosting(?Z, ?X). The variable (?Z) refers to the instance of the JobSeeker concept, and the variable (?X) refers to the instance of the JobsPosting concept. Therefore, the expression applyToJobPosting(?Z, ?X) holds if and only if an instance (?Z) applies for an instance (?X) indicating a relation between a job seeker and a job that the job seeker applied to. Likewise, the description "Job seekers apply to BTM jobs title" is expressed as shown in Table 15 and it follows a similar logic.

4.4.1 Define Rules

Similar to the axioms, necessary rules are defined in the rule table. METHONTOLOGY suggests including the following details for each rule definition: name, description, formal explanation of

the rule involved, concepts, characteristics, relations and variables [112]. The BTM Jobs ontology establishes the criteria for matching job posting requirements with job seekers' qualifications that define further rules. These rules are explained in the following chapter: BTM Jobs Ontology Matching.

4.5 Integration and Implementation

To speed up the process of building ontologies and avoid reinventing the wheel, the Integration activity involves reusing existing ontologies to enhance comprehensiveness and reduce redundancy. This may require adjusting the ontology to fit established ontologies or adapting definitions from other relevant ontologies. The implementation activity translates the formalized ontology into a computable model using appropriate ontology languages and tools such as OWL and Protégé respectively. The implementation ensures the ontology is operational and can be used for the intended applications or integrated with other systems [112] [113].

Accordingly, the development of BTM jobs ontology is inspired by reusing ideas from several existing job ontologies. The reusing of concepts and structure ideas is mainly based on the ontologies referenced in [67], [102] and the comprehensive EU HR ontology research [5] [77], [78], [79], [80], [82]. Furthermore, the structure of the BTM Jobs ontology takes into account its intended application of matching and evaluates job seekers' qualifications against corresponding job requirements. Figure 21 depicts the general structure of the BTM Jobs ontology, while Figure 22 shows a more detailed structure view.

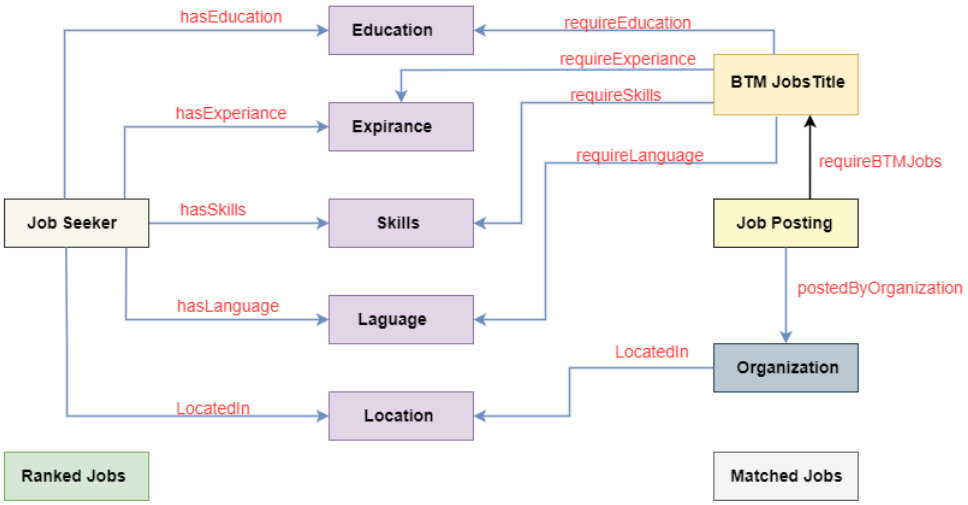

Figure 21 General BTM Jobs Ontology Structure

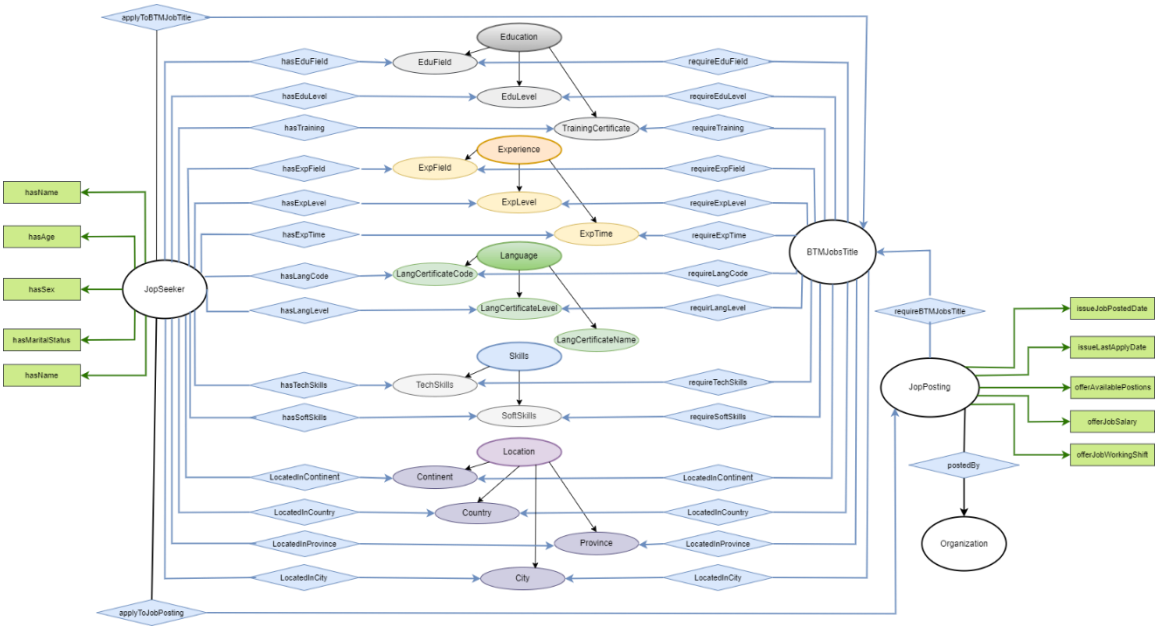

Figure 22 Detailed BTM Jobs Ontology Structure

The BTM Jobs ontology implementation is centered around semantic web technologies, mainly OWL, and uses Protégé ontology editor for the development leveraging the editor features such as class hierarchy creation, property assertions, and reasoning capabilities.

The BTM Jobs ontology is made up of several elements that are intended to organize and classify knowledge about job posting data, job seekers qualifications data, job requirements data and organization. Job requirements include classifying the knowledge and data of education, experiences, languages, skills, and location. Accordingly, corresponding job seekers qualification data and job posting data are implemented. Classes are used to represent these elements with a hierarchical structure as shown in the following Figure 23.

Figure 23 BTM Jobs Ontology Classes Hierarchy

Within the BTM jobs ontology, the following classes are primary: BTMJobsTitle, JobPosting, JobSeeker, Education, Experience, TechnicalSkills, SoftSkills, Organization, Language, and Location. There are subclasses within each of these classes. For example, the subclasses of the Education class include EduField1, EduField2, EduLevel, and Training, while the subclasses of Experience include ExpField1, ExpField2, ExpLevel, and ExpTime. The class Language also includes subclasses such as LangCerName, LangCerCode, and LangCerLevel, and TechnicalSkills class has subclasses such as TechSkills1 and TechSkills1, and similarly for SoftSkills class. Likewise, Location class allows a structured depiction of geographical features by hierarchically grouping data into subclasses such as Continent, Country, Province, and City.

Furthermore, in BTM jobs ontology defines object properties that are used to connect classes and subclasses. These properties include applyToBTMJobTitle, applyToJobPosting and requireBTMJobsTitle as shown in the following Figure 24.

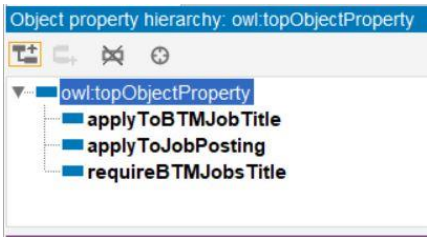

Figure 24 BTM Jobs Ontology Object Properties

As an example, the object property applyToBTMJobTitle connects JobSeeker class (the domain) with BTMJobsTitle class (the range) implying that JobSeeker instances are interrelated to BTMJobsTitle instances (JSeeker1 applyToBTMJobTitle DigitalSecurityManager/Officer). Likewise, object property applyToJobPosting links the JobSeeker class representing the domain, to the JobPosting class representing the range indicating that JobSeeker instances are interrelated to JobPosting instances (JSeeker14 applyToJobPosting JPosting3). Similarly, object property requireBTMJobsTitle is associates the JobPosting class as the domain, with the BTMJobsTitle class the range implying that JobPosting instances are interrelated to BTMJobsTitle instances (JSeeker14 applyToJobPosting JPosting3).

Moreover, the BTM jobs ontology defines data properties, including hasNameDP, hasAgeDP, and issueJobPostedDateDP, which are used to specify the data type of the classes and subclasses, as illustrated in the following Figure 25.

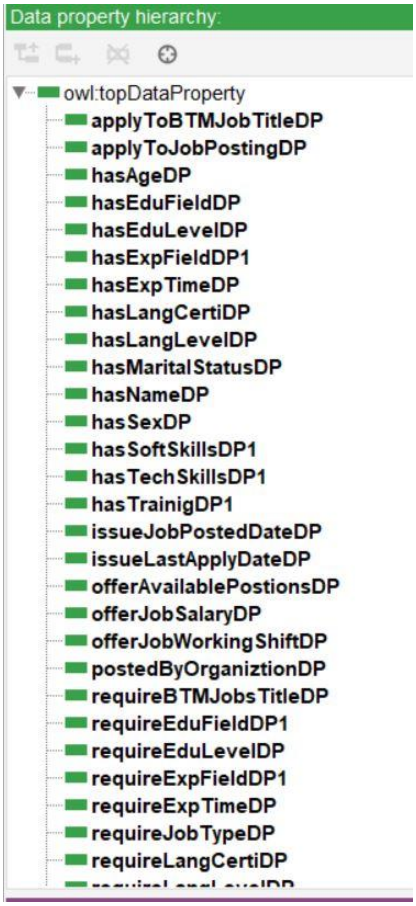

Figure 25 BTM Jobs Ontology Data Properties

For instance, the data property hasNameDP links the JobSeeker class to a given "string" value implying that an instance of JobSeeker class has a name value (JSeeker1 hasNameDP "AustinLeigh"). Likewise, the data property hasAgeDP connects the JobSeeker with a given "integer" value indicating that an instance of JobSeeker class has age value (JSeeker1 hasAgeDP "34"). Similarly, the data property offerJobSalaryDP connects the JobPosting with "decimal" value indicating that an instance of JobPosting class has datetime value (JPosting25 offerJobSalaryDP "71166.00").

Chapter 5

BTM Jobs Ontology Matching and Evaluation

5.1 Matching and Evaluation Overview

The approach adopted by this research aims to use semantic web ontology technologies and develop BTM Jobs and Job Seekers OWL ontology using Protégé editor which includes reasoners such as Pellet and SWRL with Drools rule engine for rules specifying and processing. These technologies are based on DL theory featuring the development and matching model technique [102] [99]. Based on the concepts and structure of the developed BTM jobs ontology, relationships are identified and used to build SWRL matching rules. Moreover, the research approach uses Simple Additive Weighting (SAW) a well-known Multi Criteria Decision Making (MCDM) method to evaluate job seekers' qualifications against BTM jobs requirements. SWA method, in particular is recommended for solving selection problems in MCDM scenarios due to its straightforward approach to weighting and summing performance ratings for each alternative on all attributes [102]. SAW formulas evaluate job seekers' qualification according to education, experience, and skills criteria. These formulas are then integrated in the SWRL rules to obtain the matching and evaluation results. Figure 26 depicts a high-level view of the matching and evaluation approach.

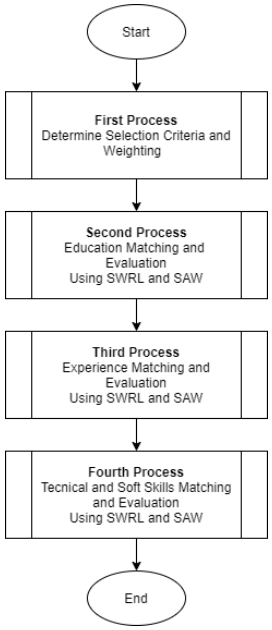

Figure 26 Matching and Evaluation Overview

The following sections explain this approach in detail.

5.2 Selection Criteria and Weighting

To use SAW, it requires assigning values and weights to the selection criteria. Then the values normalized and multiplied by the weights. The sum of the multiplication represents the SAW evaluation result of a certain alternative. Figure 27 shows a simple SAW process.

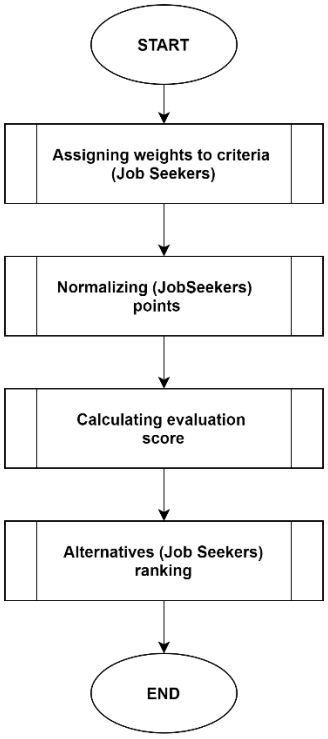

Figure 27 Simple Additive Weighting Method

The values are normalized based on the following formula:

$$\boldsymbol{r_{ij} = \frac{x_{ij}}{max_i\, x_{ij}}} \qquad \textbf{(1)}$$

Then, the alternatives (Job Seekers) are evaluated based on SAW formula:

$$V_i = \sum_{j=1}^{n} w_i\, r_{ij} \qquad \textbf{(2)}$$

In this thesis, essential jobs evaluation criteria are represented by education, experience, and skills are considered in this matching and evaluation approach.

5.2.1 Education Criteria and Weighting

Education evaluation is based on the education field and education level criteria. these criteria are assigned values and weights as shown in Table 16.

Table 16 Education Criteria and Weighting

	Education Field	Education Level
Match points	10	15
Mismatch/Less than points	5	5
Greater than by 1-degree points	-	10
Greater than by 2-degrees points	-	5
Technical Jobs Weight	*0.100*	*0.150*
Management Jobs Weight	*0.100*	*0.150*

First, the education field criterion is assigned 10 points if there is a match between a job seeker and a job education field otherwise it is assigned 5 points. Therefore, a job seeker may score a maximum of 10 points in this criterion. Following SAW method, the normalization of the education field based on formula (1) involves dividing each job seeker's points by the possible maximum points. Using SAW formula (2), each normalized point is then multiplied by education field weight which depends on whether a job is technical or managerial. In this criterion, the weight is even set at 0.100.

Second, for the education level criterion, job seekers receive 15 points if their education level matches the corresponding job education level. Moreover, if a job seeker education level is less than a job education level, it is assigned 5 points allowing a degree of tolerance instead of 0 points. Likewise, if a job seeker's education level is greater than a job education level by 1 degree, it is assigned 10 points. On the other hand, if a job seeker education level is greater than a job education level by 2 degrees, it is assigned 5 points. The two considerations of greater than in the education level (degree) allow fine-tuned evaluation as it counts for degrees variation in terms of overqualification. Accordingly, the maximum number of points a job seeker can obtain in this criterion is 15 points. To normalize the points of education level based on SAW formula (1), the points are divided by this maximum. Subsequently, using SAW formula (2), the resulting normalized points are multiplied by the weight assigned to the education level, which is set at 0.150 for both technical and managerial jobs.

Finally, the overall education evaluation according to SAW is the weighted sum of education field and education level.

5.2.2 Experience Criteria and Weighting

The evaluation of experience relies on the criteria of experience field 1, experience field 2, and experience years. These criteria are assigned specific points and weights, which are illustrated in Table 17.

Table 17 Experience Criteria and Weighting

	Experience Field1	Experience Field2	Experience Years
Match points	10	10	-
Mismatch & JS Experience Field ≠ "Nil" points	5	5	-
Experience Field = "Nil" points	0	0	-
Experience Years Match points	-	-	20
Greater than points	-	-	25
Less than points	-	-	5
JS Experience Years = 0 & Job Experience years ≠ 0 points	-	-	0
Technical Jobs Weight	*0.100*	*0.100*	*0.250*
Management Jobs Weight	*0.100*	*0.100*	*0.250*

First, this table illustrates how a job seeker's relevant experience fields match the corresponding job experience requirements. If the job seeker's experience field 1 is not "Nil" and matches one or both of the required job experience fields (field 1, field 2), it is assigned 10 points. However, if there is no match, 5 points are assigned to the job seeker's experience field 1. The same rule applies to the job seeker's experience field 2. Consequently, the criteria of experience in field 1 and field 2 allow a job seeker to achieve a maximum score of 10 points. Based on formula (1) of the SAW method, the normalization process for each experience field 1 and field 2 requires dividing the job seeker's points by the maximum possible points. Furthermore, applying the SAW formula (2), each normalized point is subsequently multiplied by the relevant weight assigned to the experience field, depending on whether the job is technical or managerial. The chosen weight for both experience field 1 and experience field 2 is 0.100.

Second, the matching and evaluation of experience years criteria involves assigning points based on several cases. If the job seeker's experience years are not equal to zero and less than the required years, 5 points are assigned. Moreover, if the job seeker's experience years match the required

years, 20 points are given. On the other hand, if the job seeker's experience years exceed the required number of years, higher points of 25 are assigned. In the case where the job seeker has no years of experience, but the required years are not zero, 0 points are assigned. Hence, the maximum points that a job seeker can achieve on this criterion is 25 points. Using the SAW formula (1), the normalization of experience years is carried out by dividing the points obtained by each job seeker by the maximum (25). Then, using the SAW formula (2), the normalized points are multiplied by the weight assigned to experience years, which differs based on whether the job is technical or managerial. In this case, the weight for this criterion is set at 0.250.

The evaluation of experience is finally obtained by summing up the results of experience field 1, experience field 2, and experience years.

5.2.3 Technical Skills Criteria and Weighting

Technical skills criteria consider evaluating only two skills: technical skill 1 and technical skill 2. These two skills are assigned points and weights, as shown in Table 18.

Table 18 Technical Skills Criteria and Weighting

	Technical Skill 1	Technical Skill 2
Match & JS JS Technical Skill ≠ "Nil" points	10	10
Mismatch & JS Technical Skill ≠ "Nil" points	5	5
Technical Skill = "Nil" points	0	0
Technical Jobs Weight	*0.100*	*0.100*
Management Jobs Weight	*0.050*	*0.050*

Table 18 demonstrates the matching and evaluation of the technical skills of a job seeker based on the technical skills required for a specific job. In case a job seeker technical skill 1 matches one or both of the required job technical skills (technical skill 1, technical skill 2), 10 points are assigned. However, if there is no match, the job seeker's technical skills 1 is assigned 5 points. If the technical skill 1 of a job seeker is "Nil", 0 points are assigned. The same matching and evaluation process applies to the job seeker's technical skills 2. Hence, the maximum points that a job seeker can achieve in both technical skill 1 and technical skill 2 is 10 points. To normalize the points using the SAW method, formula (1), it requires dividing the job seeker's points by the maximum possible

points (10) for each technical skill. Then based on formula (2) of the SAW method, the normalized points are multiplied by the corresponding weights assigned to technical skill 1 and technical skill 2 and the result is summed up. The weights assignment depends on whether the job falls under the technical or managerial type. For these particular criteria, the weight is 0.100 when the job type is technical, and 0.050 otherwise.

5.2.4 Soft Skills Criteria and Weighting

The matching and evaluation process of soft skills is typically the same as the evaluation of technical skills except of the points and weights assignment, as presented in Table 19.

Table 19 Soft Skills Criteria and Weighting

	Soft Skills 1	Soft Skills 2
Match & JS JS Soft Skills ≠ "Nil" points	5	5
Mismatch & JS Soft Skills ≠ "Nil" points	2	2
Soft Skills = "Nil" points	0	0
Technical Jobs Weight	*0.050*	*0.050*
Management Jobs Weight	*0.100*	*0.100*

The normalization of soft skill 1 and soft skill 2 is similarly based on SAW method formula (1) along with SAW weighted sum according to formula (2). Since soft skills are considered more important in management jobs, the assigned weight for these jobs is 0.100 whereas the weight of technical jobs is 0.050.

5.3 Matching and Evaluation

The main concept of BTM jobs ontology matching is based on matching each job with its job seekers. This is achieved by leveraging the concepts, design patterns and structure of the developed ontology. Based on the introduced criteria, the job seekers are matched and evaluated using SWRL rules and SAW as presented in the following sections.

5.3.1 Education Matching and Evaluation

Education evaluation is based on the field and level of education criteria. A comprehensive evaluation is achieved by matching and comparing job requirements with the qualifications of job

seekers. The evaluation approach integrates SWRL and SAW. The following sections provide a detailed discussion of this approach.

5.3.1.1 Education Level Matching and Assignment

The first education matching rules match each job with its education level, each job seeker with its education level and simultaneously assigns each level an integer value. Since Diploma, Bachelor, Masters, and Doctorate degrees are used in the job requirements, four matching SWRL rules are specified for both jobs and job seekers. Figure 28 shows the flowchart of these matching and assignment rules.

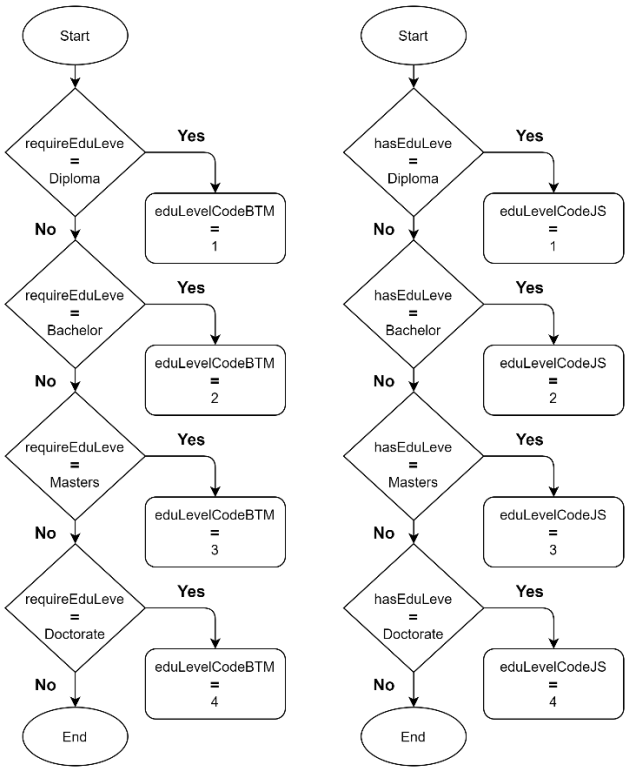

Figure 28 Assign Indicators to BTM Jobs and Job Seekers

In terms of SWRL syntax, the flowcharts shown in Figure 28 are translated to the following rules.

1- Jobs Education Level Matching and Assignment Rules

R1:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireEduLevelDP(?Bjt, ?EDLx) ^
swrlb:equal(?EDLx, “Diploma”)-> eduLevelCodeBTM(?Bjt, 1)
```

R2:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireEduLevelDP(?Bjt, ?EDLx) ^
swrlb:equal(?EDLx, "Bachelor")-> eduLevelCodeBTM(?Bjt, 2)
```

R3:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireEduLevelDP(?Bjt, ?EDLx) ^
swrlb:equal(?EDLx, "Masters")-> eduLevelCodeBTM(?Bjt, 3)
```

R4:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireEduLevelDP(?Bjt, ?EDLx) ^
swrlb:equal(?EDLx, "Doctorate")-> eduLevelCodeBTM(?Bjt, 4)
```

These rules aim to match each instance of the `BTMJobsTitle` concept with its education level based on the `hasTitle` and `requireEduLevelDP` data properties. The SWRL syntax `?Bjt` represents a variable storing each job instance and matching it with its title through *?BjtDP* variable and its education level via `?EDLx` variable. Accordingly, if any education level matches `?EDLx` value using SWRL equal function, the education level is assigned a corresponding integer value through `eduLevelCodeBTM` data property. The antecedent (body) of the SWRL rule uses a chain of conjunction (^) operator which must evaluate to true (match) to infer a new fact representing consequent (head) SWRL rule implication (->) result. The purpose of this matching, comparison and assignments is to facilitate the subsequent comparison and evaluation of corresponding job seekers' education level qualification.

Similarly, job seekers' education level qualifications are assigned integer values as shown in the following rules.

2- Job Seekers Education Level Matching and Assignment Rules

R5:

```
JobSeeker(?JS)^ hasEduLevelDP(?JS, ?EDLy)^
swrlb:equal(?EDLy, "Diploma")-> eduLevelCodeJS(?JS, 1)
```

R6:

```
JobSeeker(?JS)^ hasEduLevelDP(?JS, ?EDLy)^
```

```
swrlb:equal(?EDLy, “Bachelor”)-> eduLevelCodeJS(?JS, 2)
```

R7:

```
JobSeeker(?JS)^ hasEduLevelDP(?JS, ?EDLy)^
swrlb:equal(?EDLy, “Masters”)-> eduLevelCodeJS(?JS, 3)
```

R8:

```
JobSeeker(?JS)^ hasEduLevelDP(?JS, ?EDLy)^
swrlb:equal(?EDLy, “Doctorate”)-> eduLevelCodeJS(?JS, 4)
```

These job seekers rules serve the same purpose as the previous corresponding jobs rule which is mainly to assign same integer values for identical education levels.

5.3.1.2 Education Level Matching and Evaluation

The concept of assigning integer values in the previous rules makes comparing education levels of jobs and job seekers less complicated as shown in Figure 29.

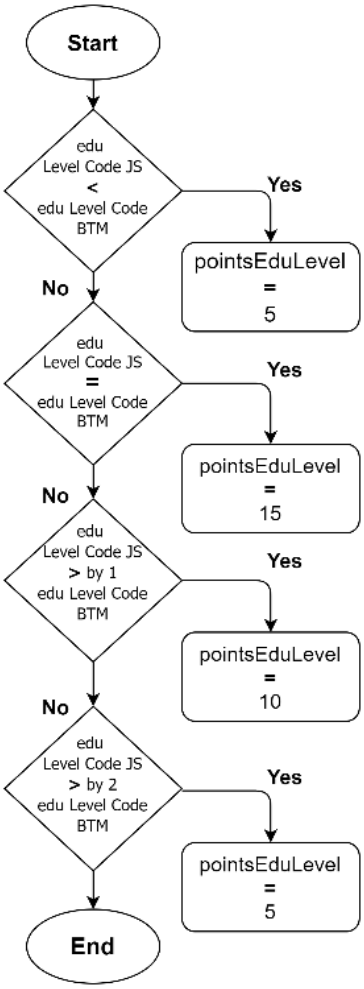

Figure 29 Education Level Matching and Evaluation

Accordingly, the following SWRL rules are specified:

R9:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
eduLevelCodeBTM(?Bjt, ?EDLx1) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
eduLevelCodeJS(?JS, ?EDLy1) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:lessThan(?EDLy1, ?EDLx1) -> pointsEduLevel(?JS, 5)
```

R10:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
eduLevelCodeBTM(?Bjt, ?EDLx2) ^
```

```
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
eduLevelCodeJS(?JS, ?EDLy2) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:equal(?EDLy2, ?EDLx2) -> pointsEduLevel(?JS, 15)
```

R11:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
eduLevelCodeBTM(?Bjt, ?EDLx3) ^
JobSeeker(?JS) ^
applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
eduLevelCodeJS(?JS, ?EDLy3) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:add(?OvrQ, ?EDLy3, 2) ^
swrlb:equal(?EDLy3, ?OvrQ) -> pointsEduLevel(?JS, 5)
```

R12:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
eduLevelCodeBTM(?Bjt, ?EDLx4) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
eduLevelCodeJS(?JS, ?EDLy4) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:add(?OvrQ, ?EDLy4, 2) ^
swrlb:greaterThan(?EDLy4, ?EDLx4)^
swrlb:lessThan(?EDLy4, ?OvrQ) -> pointsEduLevel(?JS, 10)
```

In each rule to compare education levels, job seekers for each job must be identified and matched using `applyToBTMJobTitleDP` property. Moreover, education level for each job and job seekers are stored in `?EDLx` and `?EDLy` variables respectively. Then, education levels are compared using SWRL comparison functions: `swrlb:equal`, `swrlb:lessThan` and `swrlb:greaterThan`. As shown on the rules, if a job education level equals a job seeker education level, it evaluates to 15 points If it is less than, it evaluates to 5 points, if it is greater than by 1 degree, it evaluates to 10 points, and if it is greater than by 2 degrees, it evaluates to 5 points. Consequently, the `pointsEduLevel` property is assigned one of these points depending on the fulfilled conditions.

5.3.1.3 Education Field Matching and Evaluation

Education field matching and evaluation likewise leverages the ontology design concepts, ensuring each job seeker is matched and evaluated to a corresponding job as shown in Figure 30.

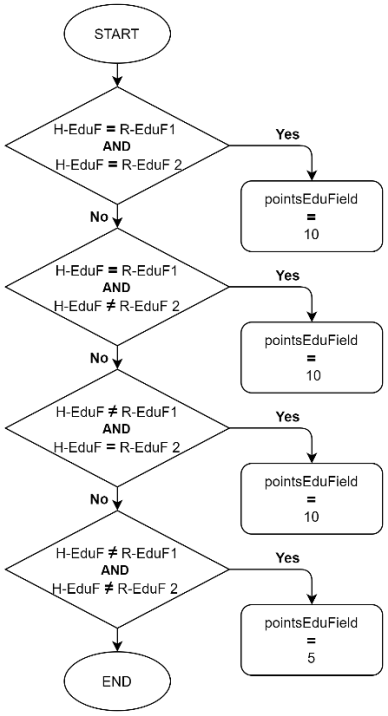

Figure 30 Education Field Matching and Evaluation

SWRL rules corresponding to the Figure 30 decision flow is developed as follows:

R13:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireEduFieldDP1(?Bjt, ?EDFx1) ^
requireEduFieldDP2(?Bjt, ?EDFx2) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasEduFieldDP(?JS, ?EDFy) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:equal(?EDFy, ?EDFx1)
swrlb:equal(?EDFy, ?EDFx2) -> pointsEduField(?JS, 10)
```

R14:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireEduFieldDP1(?Bjt, ?EDFx11) ^
```

```
requireEduFieldDP2(?Bjt, ?EDFx21) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasEduFieldDP(?JS, ?EDFy1) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:equal(?EDFy1, ?EDFx11) ^
swrlb:notEqual(?EDFy1, ?EDFx21)-> pointsEduField(?JS, 10)
```

R15:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireEduFieldDP1(?Bjt, ?EDFx12) ^
requireEduFieldDP2(?Bjt, ?EDFx22) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasEduFieldDP(?JS, ?EDFy2) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:equal(?EDFy2, ?EDFx22) ^
swrlb:notEqual(?EDFy2, ?EDFx12) -> pointsEduField(?JS, 10)
```

R16:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireEduFieldDP1(?Bjt, ?EDFx13) ^
requireEduFieldDP2(?Bjt, ?EDFx23) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasEduFieldDP(?JS, ?EDFy3) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?EDFy3, ?EDFx13) ^
swrlb:notEqual(?EDFy3, ?EDFx23) -> pointsEduField(?JS, 5)
```

Based on these rules, job seekers for each job must be first determined using `applyToBTMJobTitleDP` property. Then, job seekers' education field is evaluated against the jobs two fields of education using SWRL comparison functions: `swrlb:equal` and `swrlb:notEqual`. As shown in the rules, if a job seeker's education filed matches any of the required two education fields, it evaluates to 10 points otherwise it evaluates to 5. Then, one of these points is assigned to the `pointsEduField` property based on the satisfied conditions.

5.3.2 Education Evaluation Using SAW and SWRL

The obtained education field and level points from the previous matching and evaluation are first normalized based on SAW formula (1). Then this normalization is integrated in SWRL rules as follows:

R17:

```
JobSeeker(?JS) ^
pointsEduLevel(?JS, ?el) ^
swrlb:divide(?div1, ?el, 15) -> normalizedEduLevel(?JS, ?div1)
```

R18:

```
JobSeeker(?JS) ^
pointsEduField(?JS, ?edf) ^
swrlb:divide(?div2, ?edf, 10) -> normalizedEduField(?JS, ?div2)
```

As shown R17 and R18 rules, the points are normalized by dividing by the maximum using SWRL divide function. Next, the SAW formula (2) is integrated in SWRL rules as follows:

R19:

```
JobSeeker(?JS) ^
normalizedEduLevel(?JS, ?norm1) ^
normalizedEduField(?JS, ?norm2) ^
swrlb:multiply(?ma, 0.150, ?norm1) ^
swrlb:multiply(?mb, 0.100, ?norm2) ^
swrlb:add(?SumT1, ?mb, ?ma)
swrlb:multiply(?EDevlSC, 100, ?SumT1) -> educationEvaluationScore(?JS,
?EDevlSC)
```

The R19 rule takes the normalized points and multiplies them with their corresponding weights. It then sums up the multiplication results and converts it to percentage representing the final education evaluation saved in `EDPoints` variable via `educationPoints` property.

5.3.3 Experience Matching and Evaluation

Experience evaluation includes field and level of experience criteria. it involves comparing and matching job experience requirements with job seekers' corresponding qualifications. This enables a comprehensive evaluation of experience by determining the compatibility of job seekers with

specific job requirements in a multi criteria and rule-driven approach using SWRL and SAW. The following sections discuss this approach in detail.

5.3.3.1 Experience Field Matching and Evaluation

The evaluation and comparison of the experience field is conducted by assessing the required experience field for each job and matching it with the experience field of job seekers as shown in Figure 31

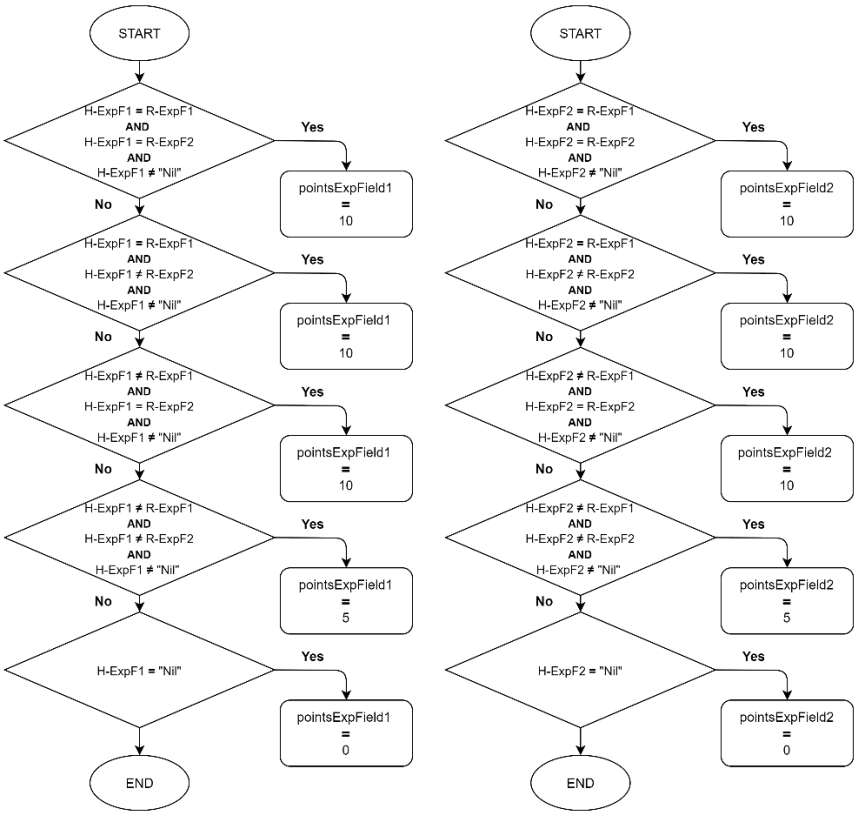

Figure 31 Experience Field Matching and Evaluation

The procedure shown in Figure 31 summarizes the matching and evaluation of experience. This procedure is implemented using matching techniques based on the following SWRL rules:

R20:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpFieldDP1(?Bjt, ?ExpFx1) ^
requireExpFieldDP2(?Bjt, ?ExpFx2) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpFieldDP1(?JS, ?ExpFy1) ^
```

```
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpFy1, "Nil") ^
swrlb:equal(?ExpFy1, ?ExpFx1) ^
swrlb:equal(?ExpFy1, ?ExpFx2) -> pointsExpField1(?JS, 10)
```

R21:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpFieldDP1(?Bjt, ?ExpFx11) ^
requireExpFieldDP2(?Bjt, ?ExpFx21) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpFieldDP1(?JS, ?ExpFy11) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpFy11, "Nil") ^
swrlb:equal(?ExpFy11, ?ExpFx11) ^
swrlb:notEqual(?ExpFy11, ?ExpFx21) -> pointsExpField1(?JS, 10)
```

R22:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpFieldDP1(?Bjt, ?ExpFx12) ^
requireExpFieldDP2(?Bjt, ?ExpFx22) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpFieldDP1(?JS, ?ExpFy12) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpFy12, "Nil") ^
swrlb:notEqual(?ExpFy12, ?ExpFx12) ^
swrlb:equal(?ExpFy12, ?ExpFx22) -> pointsExpField1(?JS, 10)
```

R23:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpFieldDP1(?Bjt, ?ExpFx13) ^
requireExpFieldDP2(?Bjt, ?ExpFx23) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpFieldDP1(?JS, ?ExpFy13) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpFy13, "Nil") ^
swrlb:notEqual(?ExpFy13, ?ExpFx13) ^
```

```
swrlb:notEqual(?ExpFy13, ?ExpFx23) -> pointsExpField1(?JS, 5)
```

R24:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpFieldDP1(?Bjt, ?ExpFx14) ^
requireExpFieldDP1(?Bjt, ?ExpFx24) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpFieldDP2(?JS, ?ExpFy24) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpFy24, "Nil") ^
swrlb:equal(?ExpFy24, ?ExpFx14) ^
swrlb:equal(?ExpFy24, ?ExpFx24) -> pointsExpField2(?JS, 10)
```

R25:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpFieldDP1(?Bjt, ?ExpFx15) ^
requireExpFieldDP2(?Bjt, ?ExpFx25) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpFieldDP2(?JS, ?ExpFy25) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpFy25, "Nil") ^
swrlb:equal(?ExpFy25, ?ExpFx15) ^
swrlb:notEqual(?ExpFy25, ?ExpFx25) -> pointsExpField2(?JS, 10)
```

R26:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpFieldDP1(?Bjt, ?ExpFx16) ^
requireExpFieldDP2(?Bjt, ?ExpFx26) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpFieldDP2(?JS, ?ExpFy26) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpFy26, "Nil") ^
swrlb:notEqual(?ExpFy26, ?ExpFx16) ^
swrlb:equal(?ExpFy26, ?ExpFx26) -> pointsExpField2(?JS, 10)
```

R27:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpFieldDP1(?Bjt, ?ExpFx17) ^
requireExpFieldDP2(?Bjt, ?ExpFx27) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpFieldDP2(?JS, ?ExpFy27) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpFy27, "Nil") ^
swrlb:notEqual(?ExpFy27, ?ExpFx17) ^
swrlb:notEqual(?ExpFy27, ?ExpFx27) -> pointsExpField2(?JS, 5)
```

R28:

```
JobSeeker(?JS) ^
hasExpFieldDP1(?JS, ?ExpFy18) ^
swrlb:equal(?ExpFy18, "Nil") -> pointsExpField1(?JS, 0)
```

R29:

```
JobSeeker(?JS) ^
hasExpFieldDP2(?JS, ?ExpFy28) ^
swrlb:equal(?ExpFy28, "Nil") -> pointsExpField2(?JS, 0)
```

These rules involve the utilization of the `BTMJobsTitle` concept and its properties (`requireExpFieldDP1`) and (`requireExpFieldDP2`), which are associated with the variables (`ExpFx1` and `ExpFx2`). Likewise, the rules incorporate the `JobSeeker` concept and its properties (`hasExpFieldDP1`) and (`hasExpFieldDP2`) captured in the variables (`ExpFy1` and `ExpFy2`). Moreover, SWRL functions `swrlb:equal` and `swrlb:notEqual` are used to compare specific data properties. Accordingly, new facts are inferred representing `pointsExpField1` and `pointsExpField2` values. Since the BTM jobs ontology includes two experience fields for each job and job seeker, each job seeker experience field is compared with the two experience fields required by the corresponding job. Thus, whenever a job seeker's experience field matches a job experience field, it is assigned 10 points; otherwise, it is assigned 5 points; and if the job seeker experience field is "Nil" it is assigned 0 points.

5.3.3.2 Experience Years Matching and Evaluation

The second set of experience rules address the matching and evaluation of experience years. Figure 32 depicts the procedure of these rules.

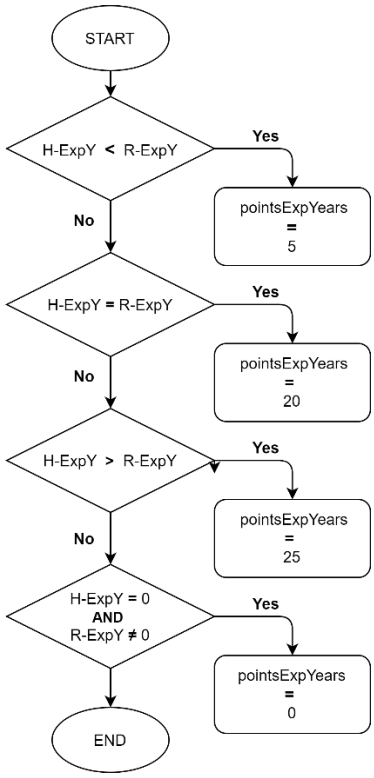

Figure 32 Experience Years Matching and Evaluation

The corresponding SWRL rules are specified as follows:

R30:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpYearsDP(?Bjt, ?ExpYx) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpYearsDP(?JS, ?ExpYy) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?ExpYy, 0) ^
swrlb:lessThan(?ExpYy, ?ExpYx) -> pointsExpYears(?JS, 5)
```

R31:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpYearsDP(?Bjt, ?ExpYx1) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpYearsDP(?JS, ?ExpYy1) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
```

```
swrlb:equal(?ExpYy1, ?ExpYx1) -> pointsExpYears(?JS, 20)
```

R32:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpYearsDP(?Bjt, ?ExpYx2) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasExpYearsDP(?JS, ?ExpYy2) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:greaterThan(?ExpYy2, ?ExpYx2) -> pointsExpYears(?JS, 25)
```

R33:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireExpYearsDP(?Bjt, ?ExpYx3) ^
JobSeeker(?JS)
hasExpYearsDP(?JS, ?ExpYy3) ^
swrlb:notEqual(?ExpYx3, 0) ^
swrlb:equal(?ExpYy3, 0) -> pointsExpYears(?JS, 0)
```

R30, R31, R32 and R33 rules examine the matching and comparison between the required experience years (`ExpYx`) of job instances and the corresponding qualification experience years (`ExpYy`) of job seekers. To perform this evaluation, SWRL functions: `swrlb:lessThan`, `swrlb:equal`, and `swrlb:greaterThan` are used. Accordingly, a job seeker's years of experience is assigned 5 points if it is below, 20 points if it is equal, 25 if it exceeds the job required years of experience, and 0 points only if it is equal 0 and job experience years is not equal 0. This results in adding new inferred facts represented by the `pointsExpYears` predicate. The associated values (0, 5, 20, and 25) allow for more fine-tuned evaluation of years of experience.

5.3.4 Experience Evaluation Using SAW and SWRL

The SAW formula (1) is applied to normalize the obtained points of experience field 1, experience field 2, and experience years. The normalization process is integrated with the SWRL rules as follows:

R34:

```
JobSeeker(?JS) ^
pointsExpField1(?JS, ?exf1) ^
swrlb:divide(?div3, ?exf1, 10) -> normalizedExpField1(?JS, ?div3)
```

R35:

```
JobSeeker(?JS) ^
pointsExpField2(?JS, ?exf1) ^
swrlb:divide(?div4, ?exf1, 10) -> normalizedExpField2(?JS, ?div4)
```

R36:

```
JobSeeker(?JS) ^
pointsExpYears(?JS, ?exYr) ^
swrlb:divide(?div5, ?exYr, 25) -> normalizedExpYears(?JS, ?div5)
```

The process of normalizing the points for each criterion in the R34, R35, and R36 rules involves dividing the points by their respective maximum using the SWRL divide function. Afterwards, the SAW formula (2) is integrated with SWRL to compute criteria evaluation as shown in the following rules:

R37:

```
JobSeeker(?JS) ^
normalizedExpField1(?JS, ?norm3) ^
normalizedExpField2(?JS, ?norm4) ^
normalizedExpYears(?JS, ?norm5) ^
swrlb:multiply(?mc, 0.100, ?norm3) ^
swrlb:multiply(?md, 0.100, ?norm4) ^
swrlb:multiply(?me, 0.250, ?norm5) ^
swrlb:add(?SumT2, ?md, ?mc) ^
swrlb:add(?SumT3, ?SumT2, ?me) ^
swrlb:multiply(?EXevlSc, 100, ?SumT3) -> experienceEvaluationScore(?JS,
?EXevlSc)
```

The R37 rule is used to evaluate experience by multiplying normalized points with their corresponding weights. The resulting products are added together and converted into a percentage. The final result is stored in the "`experienceEvaluationScore`" property using the"`EXevlSc`" variable.

5.3.5 Skills Matching and Evaluation

Skills evaluation considers technical and soft skills criteria categories. This enables distinguishing the evaluation of technical and soft skills based on the combined approach of SWRL and SAW. The following sections provide a detailed discussion of this approach.

5.3.5.1 Technical Matching and Evaluation

In the context of technical skills matching and evaluation, a set of SWRL rules are devised to compare jobs technical skills requirements with job seekers' technical skills qualifications. This process is illustrated in the following Figure 33.

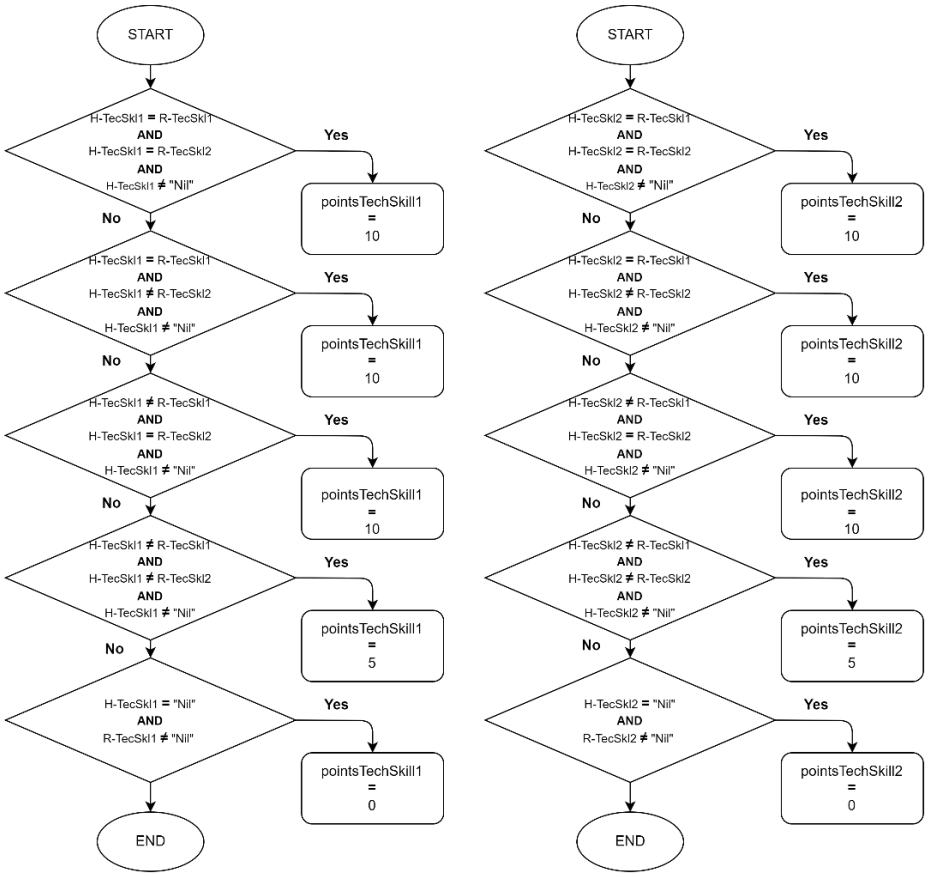

Figure 33 Technical Matching and Evaluation

The procedure shown in Figure 33 is interpreted in terms of SWRL rules as follows:

R38:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireTechSkillsDP1(?Bjt, ?TchSKx1) ^
requireTechSkillsDP2(?Bjt, ?TecSklx2) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasTechSkillsDP1(?JS, ?TecSkly1) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?TecSkly1, "Nil") ^
```

```
swrlb:equal(?TecSkly1, ?TecSklx1) ^
swrlb:equal(?TecSkly1, ?TecSklx2) -> pointsTechSkill1(?JS, 10)
```

R39:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireTechSkillsDP1(?Bjt, ?TecSklx11) ^
requireTechSkillsDP2(?Bjt, ?TecSklx21) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasTechSkillsDP1(?JS, ?TecSkly11) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?TecSkly11, "Nil") ^
swrlb:equal(?TecSkly11, ?TecSklx11) ^
swrlb:notEqual(?TecSkly11, ?TecSklx21) -> pointsTechSkill1(?JS, 10)
```

R40:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireTechSkillsDP1(?Bjt, ?TecSklx12) ^
requireTechSkillsDP2(?Bjt, ?TecSklx22) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasTechSkillsDP1(?JS, ?TecSkly12) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?TecSkly12, "Nil") ^
swrlb:notEqual(?TecSkly12, ?TecSklx12) ^
swrlb:equal(?TecSkly12, ?TecSklx22) -> pointsTechSkill1(?JS, 10)
```

R41:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireTechSkillsDP1(?Bjt, ?TecSklx13) ^
requireTechSkillsDP2(?Bjt, ?TecSklx23) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasTechSkillsDP1(?JS, ?TecSkly13) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?TecSkly13, "Nil") ^
swrlb:notEqual(?TecSkly13, ?TecSklx13) ^
swrlb:notEqual(?TecSkly13, ?TecSklx23) -> pointsTechSkill1(?JS, 5)
```

R42:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireTechSkillsDP1(?Bjt, ?TecSklx14) ^
requireTechSkillsDP1(?Bjt, ?TecSklx24) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasTechSkillsDP2(?JS, ?TecSkly24) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?TecSkly24, "Nil") ^
swrlb:equal(?TecSkly24, ?TecSklx14) ^
swrlb:equal(?TecSkly24, ?TecSklx24) -> pointsTechSkill2(?JS, 10)
```

R43:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireTechSkillsDP1(?Bjt, ?TecSklx15) ^
requireTechSkillsDP2(?Bjt, ?TecSklx25) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasTechSkillsDP2(?JS, ?TecSkly25) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?TecSkly25, "Nil") ^
swrlb:equal(?TecSkly25, ?TecSklx15) ^
swrlb:notEqual(?TecSkly25, ?TecSklx25) -> pointsTechSkill2(?JS, 10)
```

R44:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireTechSkillsDP1(?Bjt, ?TecSklx16) ^
requireTechSkillsDP2(?Bjt, ?TecSklx26) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasTechSkillsDP2(?JS, ?TecSkly26) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?TecSkly26, "Nil") ^
swrlb:notEqual(?TecSkly26, ?TecSklx16) ^
swrlb:equal(?TecSkly26, ?TecSklx26) -> pointsTechSkill2(?JS, 10)
```

R45:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireTechSkillsDP1(?Bjt, ?TecSklx17) ^
```

```
requireTechSkillsDP2(?Bjt, ?TecSklx27) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasTechSkillsDP2(?JS, ?TecSkly27) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?TecSkly27, "Nil") ^
swrlb:notEqual(?TecSkly27, ?TecSklx17) ^
swrlb:notEqual(?TecSkly27, ?TecSklx27) -> pointsTechSkill2(?JS, 5)
```

R46:

```
JobSeeker(?JS) ^
hasTechSkillsDP1(?JS, ?TecSkly18) ^
swrlb:equal(?TecSkly18, "Nil") -> pointsTechSkill1(?JS, 0)
```

R47:

```
JobSeeker(?JS) ^
hasTechSkillsDP2(?JS, ?TecSkly28) ^
swrlb:equal(?TecSkly28, "Nil") -> pointsTechSkill2(?JS, 0)
```

These rules aim to match each instance of the `BTMJobsTitle` concept with its technical skills requirements based on the `hasTitle`, `requireTechSkillsDP1` and `requireTechSkillsDP2` data properties. The rules use SWRL functions: `swrlb:equal` and `swrlb:notEqual` to determine if a match exists. A matched skill is assigned 10 points whereas an unmatched skill is assigned 5 points, except job seeker technical skills equal "Nil" while job technical skills not equal to 0 then it assigned 0 points. These assignments are added as new inferred facts via `pointsTechSkill1` and `pointsTechSkill2` data properties.

5.3.5.2 Technical Skills Evaluation Using SAW and SWRL

The technical skill 1 and technical skill 2 points acquired from the previous matching and evaluation are normalized based on the SAW formula (1) as shown in the following SWRL rules:

R48:

```
JobSeeker(?JS) ^
pointsTechSkill1(?JS, ?tcsk1) ^
swrlb:divide(?div6, ?tcsk1, 10) -> normalizedTechSkill1(?JS, ?div6)
```

R49:

```
JobSeeker(?JS) ^
```

```
pointsTechSkill2(?JS, ?tcsk2) ^
swrlb:divide(?div7, ?tcsk2, 10) -> normalizedTechSkill2(?JS, ?div7)
```

The SWRL divide function is used to normalize the points for each criterion in the R48 and R49 rules. This normalization involves dividing the points by their maximum. To calculate the evaluation of these criteria, SAW formula (2) is then used in the following SWRL rules:

R50:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
jobDutypattern(?Bjt, ?JDP1) ^
JobSeeker(?JS) ^  applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:equal(?JDP1, 1) ^
normalizedTechSkill1(?JS, ?norm6) ^
normalizedTechSkill2(?JS, ?norm7) ^
swrlb:multiply(?mf, 0.100, ?norm6) ^
swrlb:multiply(?mg, 0.100, ?norm7) ^
swrlb:add(?SumT4, ?mg, ?mf) ^
swrlb:multiply(?TSevlSc1, 100, ?SumT4) ->
techSkillsEvaluationScore(?JS, ?TSevlSc1)
```

R51:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
jobDutypattern(?Bjt, ?JDP3) ^
JobSeeker(?JS) ^  applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:equal(?JDP3, 2) ^
normalizedTechSkill1(?JS, ?norm60) ^
normalizedTechSkill2(?JS, ?norm70) ^
swrlb:multiply(?mf2, 0.050, ?norm60) ^
swrlb:multiply(?mg2, 0.050, ?norm70) ^
swrlb:add(?SumT42, ?mg2, ?mf2) ^
swrlb:multiply(?TSevlSc3, 100, ?SumT42) ->
techSkillsEvaluationScore(?JS, ?TSevlSc3)
```

The R50 and R51 rules involve multiplying normalized points with their respective weights. These rules introduce an important concept of distinguishing the weights of technical and managerial jobs. Such that, if a job is technical as indicated by `jobDutypattern` property and `?JDP1` variable with a value equals to 1, its weight is set at 0.100. on the other hand, managerial jobs are assigned a weight of 0.050. The products obtained from this calculation are then summed up and transformed into a percentage which is stored in the "`techSkillsEvaluationScore`" property, using the "`TSevlSc1`" and "`TSevlSc3`" variables depending on if a job is technical (R50) or a job is managerial (R51).

5.3.5.3 Soft Skills Matching and Evaluation

Similar to technical skills, soft skills are matched and evaluated using a set of SWRL rules. Figure 34 shows the matching and evaluation procedure:

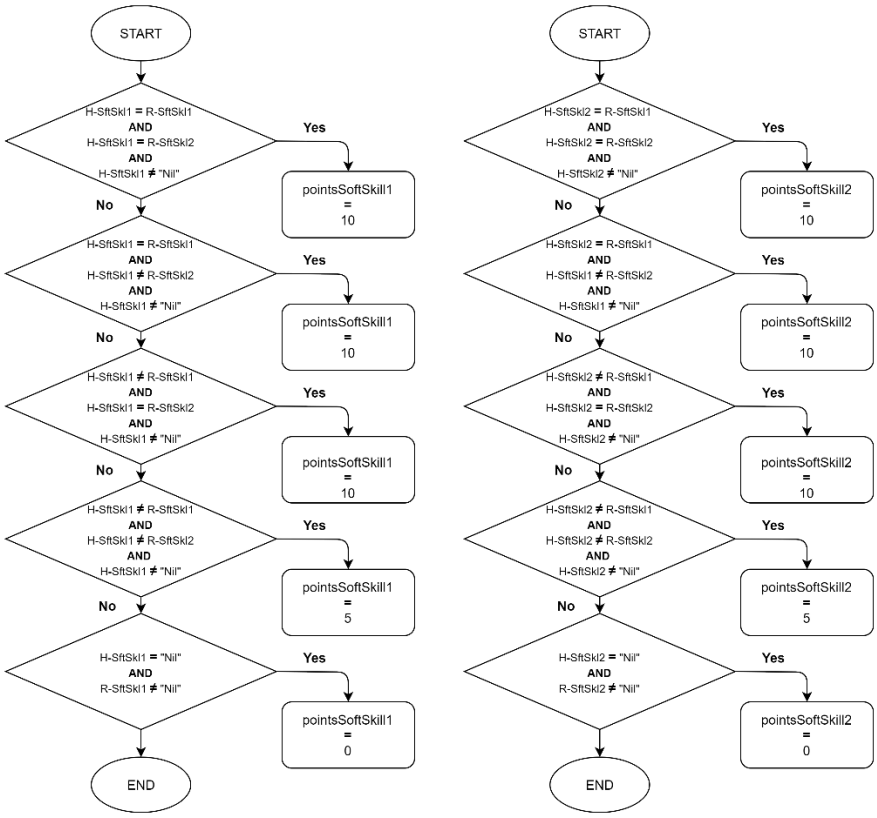

Figure 34 Soft Skills Matching and Evaluation

The specified SWRL rules for soft skills are as follows:

R52:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
```

```
requireSoftSkillsDP1(?Bjt, ?SoftSklx1) ^
requireSoftSkillsDP2(?Bjt, ?SoftSklx2) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasSoftSkillsDP1(?JS, ?SoftSkly1) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?SoftSkly1, "Nil") ^
swrlb:equal(?SoftSkly1, ?SoftSklx1) ^
swrlb:equal(?SoftSkly1, ?SoftSklx2) -> pointsSoftSkill1(?JS, 5)
```

R53:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireSoftSkillsDP1(?Bjt, ?SoftSklx11) ^
requireSoftSkillsDP2(?Bjt, ?SoftSklx21) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasSoftSkillsDP1(?JS, ?SoftSkly11) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?SoftSkly11, "Nil") ^
swrlb:equal(?SoftSkly11, ?SoftSklx11) ^
swrlb:notEqual(?SoftSkly11, ?SoftSklx21) -> pointsSoftSkill1(?JS, 5)
```

R54:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireSoftSkillsDP1(?Bjt, ?SoftSklx12) ^
requireSoftSkillsDP2(?Bjt, ?SoftSklx22) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasSoftSkillsDP1(?JS, ?SoftSkly12) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?SoftSkly12, "Nil") ^
swrlb:notEqual(?SoftSkly12, ?SoftSklx12) ^
swrlb:equal(?SoftSkly12, ?SoftSklx22) -> pointsSoftSkill1(?JS, 5)
```

R55:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireSoftSkillsDP1(?Bjt, ?SoftSklx13) ^
requireSoftSkillsDP2(?Bjt, ?SoftSklx23) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
```

```
hasSoftSkillsDP1(?JS, ?SoftSkly13) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?SoftSkly13, "Nil") ^
swrlb:notEqual(?SoftSkly13, ?SoftSklx13) ^
swrlb:notEqual(?SoftSkly13, ?SoftSklx23) -> pointsSoftSkill1(?JS, 2)
```

R56:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireSoftSkillsDP1(?Bjt, ?SoftSklx14) ^
requireSoftSkillsDP1(?Bjt, ?SoftSklx24) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasSoftSkillsDP2(?JS, ?SoftSkly24) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?SoftSkly24, "Nil") ^
swrlb:equal(?SoftSkly24, ?SoftSklx14) ^
swrlb:equal(?SoftSkly24, ?SoftSklx24) -> pointsSoftSkill2(?JS, 5)
```

R57:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireSoftSkillsDP1(?Bjt, ?SoftSklx15) ^
requireSoftSkillsDP2(?Bjt, ?SoftSklx25) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasSoftSkillsDP2(?JS, ?SoftSkly25) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?SoftSkly25, "Nil") ^
swrlb:equal(?SoftSkly25, ?SoftSklx15) ^
swrlb:notEqual(?SoftSkly25, ?SoftSklx25) -> pointsSoftSkill2(?JS, 5)
```

R58:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireSoftSkillsDP1(?Bjt, ?SoftSklx16) ^
requireSoftSkillsDP2(?Bjt, ?SoftSklx26) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasSoftSkillsDP2(?JS, ?SoftSkly26) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?SoftSkly26, "Nil") ^
```

```
swrlb:notEqual(?SoftSkly26, ?SoftSklx16) ^
swrlb:equal(?SoftSkly26, ?SoftSklx26) -> pointsSoftSkill2(?JS, 5)
```

R59:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
requireSoftSkillsDP1(?Bjt, ?SoftSklx17) ^
requireSoftSkillsDP2(?Bjt, ?SoftSklx27) ^
JobSeeker(?JS) ^ applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
hasSoftSkillsDP2(?JS, ?SoftSkly27) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:notEqual(?SoftSkly27, "Nil") ^
swrlb:notEqual(?SoftSkly27, ?SoftSklx17) ^
swrlb:notEqual(?SoftSkly27, ?SoftSklx27) -> pointsSoftSkill2(?JS, 2)
```

R60:

```
JobSeeker(?JS) ^
hasSoftSkillsDP1(?JS, ?SoftSkly18) ^
swrlb:equal(?SoftSkly18, "Nil") -> pointsSoftSkill1(?JS, 0)
```

R61:

```
JobSeeker(?JS) ^
hasSoftSkillsDP2(?JS, ?SoftSkly28) ^
swrlb:equal(?SoftSkly28, "Nil") -> pointsSoftSkill2(?JS, 0)
```

These rules follow a similar approach to the technical skills matching rules, utilizing the developed ontology concepts and relations as well as SWRL functions to match and evaluate job seekers' soft skills against the job requirements. The results of these evaluations are saved through the pointsSoftSkill1 and pointsSoftSkill2 properties.

5.3.5.4 Soft Skills Evaluation Using SAW and SWRL

The normalization of the soft skill 1 and soft skill 2 points resulted from the previous matching and evaluation is performed using the SAW formula (1) as presented in the following SWRL rules:

R62:

```
JobSeeker(?JS) ^
pointsSoftSkill1(?JS, ?sfsk1) ^
swrlb:divide(?div8, ?sfsk1, 5) -> normalizedSoftSkill1(?JS, ?div8)
```

R63:

```
JobSeeker(?JS) ^
pointsSoftSkill2(?JS, ?sfsk2) ^
swrlb:divide(?div9, ?sfsk2, 5) -> normalizedSoftSkill2(?JS, ?div9)
```

In the R62 and R63 rules, the SWRL divide function is used to normalize the points by dividing each point by its maximum. SAW formula (2) is subsequently implemented in SWRL rules as follows:

R64:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
jobDutypattern(?Bjt, ?JDP2) ^
JobSeeker(?JS) ^  applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:equal(?JDP2, 1) ^
normalizedSoftSkill1(?JS, ?norm8) ^
normalizedSoftSkill2(?JS, ?norm9) ^
swrlb:multiply(?mh, 0.050, ?norm8) ^
swrlb:multiply(?mi, 0.050, ?norm9) ^
swrlb:add(?SumT5, ?mi, ?mh) ^
swrlb:multiply(?SSevlSc2, 100, ?SumT5) ->
SoftSkillsEvaluationScore(?JS, ?SSevlSc2)
```

R65:

```
BTMJobsTitle(?Bjt) ^ hasTitle(?Bjt, ?BjtDP) ^
jobDutypattern(?Bjt, ?JDP4) ^
JobSeeker(?JS) ^  applyToBTMJobTitleDP(?JS, ?BjtJSDP) ^
swrlb:equal(?BjtDP, ?BjtJSDP) ^
swrlb:equal(?JDP4, 2) ^
normalizedSoftSkill1(?JS, ?norm80) ^
normalizedSoftSkill2(?JS, ?norm90) ^
swrlb:multiply(?mh2, 0.100, ?norm80) ^
swrlb:multiply(?mi2, 0.100, ?norm90) ^
swrlb:add(?SumT52, ?mi2, ?mh2) ^
swrlb:multiply(?SSevlSc4, 100, ?SumT52) ->
softSkillsEvaluationScore(?JS, ?SSevlSc4)
```

Therefore, the evaluation of soft skills in the R64 and R65 rules require multiplying normalized points by their respective weights. The distinction between R64 and R65 lies in the fact that R64 uses the weight (0.050) assigned to the technical jobs, while R65 utilizes the weight (0.100) assigned to the managerial jobs. The products obtained from this calculation are then summed up and converted into a percentage which is stored in the "`softSkillsEvaluationScore`" property via `?SSevlSc2` and `?SSevlSc4` variables depending on job type.

5.3.6 Final Score Evaluation

For each job seeker, the final score evaluation is simply the sum of the results of the education evaluation, experience evaluation, technical skills evaluation, and soft skills evaluation as shown in the following SWRL rule:

R66

```
JobSeeker(?JS) ^
educationEvaluationScore(?JS, ?EDPs) ^
experienceEvaluationScore(?JS, ?EXPs) ^
techSkillsEvaluationScore(?JS, ?TSPs) ^
softSkillsEvaluationScore(?JS, ?SSPs) ^
swrlb:add(?SumT6, ?EXPs, ?EDPs) ^
swrlb:add(?SumT7, ?SumT6, ?TSPs) ^
swrlb:add(?SumT8, ?SumT7, ?SSPs) -> totalEvaluationScore (?JS, ?SumT8)
```

The R66 rule builds on the previous rules by adding the obtained score of education, experience, technical skills, and soft skills retrieved from their respective properties and stored in the variables as shown in the rule. The final score evaluation is then stored in the `totalEvaluationScore` property through `?SumT8` variable.

Chapter 6

Results Discussion

6.1 Overview

One of the main research questions stated in this thesis (RQ1) is how to improve HRM recruitment and selection processes in terms of enhanced automation and accuracy, subsequently reducing time and cost. To address this question, the thesis developed BTM jobs and job seekers OWL ontology and a matching approach on top of the ontology that allows to match and evaluate the job seekers using the SWRL and MCDM method represented by SAW. In short, the work carried out by this research includes analyzing BTM jobs to identify ontology concepts and relations as well as jobs requirements (RQ2), developing BTM jobs ontology (RQ3), identifying matching and selection criteria and implementing them using SWRL rules and SAW evaluation (RQ4), assessing the approach and its implementation (RQ5) and (RQ6) and generalizing the research approach for use in other jobs rather than just BTM jobs (RQ7).

6.2 BTM Jobs Ontology Development Results

The development of BTM jobs ontology is based on METHONTOLOGY and implemented using Protégé ontology editor. Chapter 4 detailed the development of BTM jobs ontology and reviewed several similar approaches, and the following Table 20 provides a high-level view comparison between BTM jobs ontology development concepts and some of the similar reviewed ontologies [67], [76], [83].

Table 20 Comparing Thesis Developed BTM Jobs Ontology with Related Studies

	BTM Jobs Ontology	**Job Description Ontology** [67]	**SEEMP project** [76], [77], [78], [79], [80], [81]	**Towards An Ontology-Based Knowledge Base for Job Postings** [83]
Case	BTM jobs and job seekers ontology	Job description ontology for e-recruitment	Reference ontology network and local ontology networks for EU labor market	Ontology-based IT job postings analysis
Methodology	METHONTOLOGY	Uschold, King's Enterprise	NeOn , METHONTOLOGY	Rule-based ontology population with named entity recognition and text processing
Tools	Protégé, OWL	Protégé, OWL, SPARQL	WebODE, WSML, WSMO	Protégé, OWL, Jena Fuseki Server, SPARQL, Stanza NLP toolkit

	BTM Jobs Ontology	**Job Description Ontology** [67]	**SEEMP project** [76], [77], [78], [79], [80], [81]	**Towards An Ontology-Based Knowledge Base for Job Postings** [83]
Ontology model	- Separates job requirements and job postings concepts for enhanced reusability - Integrates job seekers qualifications - Structured for matchmaking between jobs and job seekers	Divides concepts of job description and job position for enhanced reuse	Standardized English reference ontology network and local ontology networks for specific EU countries labor market needs with semantic mappings	Defines IT job postings concepts based on SARO and ESCO vocabulary
Limitation	- Considers only essential jobs requirements and job seekers qualifications.	- Potential challenges in reuse and integration - efficient in application-driven scenarios without a gold standard for comparison	Challenges related to availability, completeness, and performance	- Specific to IT job postings - Limited to English for data extraction but aims to support multi-language
Advantages	Offers matching and evaluation of Job seekers with BTM jobs.	- Enhanced job description creation - Job portal sharing - Evaluated by domain coverage comparison and application-based method - Potential use in matching	- Semantic interoperability enabling exchange of CVs and job offers across EU employment and languages - Rapid ontologies development by reuse and reengineering	- Globally accessible knowledge base - Supports automation and reuse in various applications - Potential use in matchmaking applications

6.2.1 Importing BTM Jobs and Job Seekers Data

Based on the developed BTM jobs ontology structure and properties, an Excel workbook is developed with 9 Excel sheets containing jobs and job seekers' data. The complete imported data is provided in Appendices F and G and the following list briefly highlights each Excel sheet's data.

1- **Job Posting:** This Excel sheet contains 27 job posting instances data representing the instances properties and facts such as job posting ID and required BTM job title property that links the job posting with its corresponding job requirements.

2- **BTM Jobs Requirements:** This Excel sheet has BTM jobs titles instances with their corresponding property and requirement facts such as education, experience, and skills.

3- **Job Seekers:** This Excel sheet includes the qualification data of 160 job seeker instances. This data represents examples of job seekers with randomly assigned qualifications. It defines job seeker ID, name, age, sex, as well as properties with their corresponding qualification facts including education, experience, and skills.

4- **Education:** This Excel sheet contains 21 education fields, 4 education levels, and 36 training certificates instances.

5- **Experience:** This Excel sheet holds 84 experience fields, 30 experience years, and 6 experience level instances.

6- **Skills:** This Excel sheet contains 134 technical skills and 61 soft skills instances.

7- **Language:** This Excel sheet has 6 language certificate codes, 6 language certificate names, and 3 language certificate level instances.

8- **Location:** This Excel sheet holds 7 continents, 243 countries, 13 provinces in Canada, and 221 cities in Canada instances.

9- **Organization:** This Excel sheet contains 25 organizational instances.

The following Table 21 shows an example of the import data for Job Postings.

Table 21 Example of Job Postings Excel Imported Data

Job Posting No	BTM Job Title	Organization Name	Job Posted Date	Last Apply Date	Job Working Shift	Job Type	Available Positions	Job Salary
JPosting1	DigitalSecurityManagerOfficer	DesjardinsGroup	12/3/2024	12/6/2024	Morning	FullTime	1	199512.00
JPosting2	BusinessAnalystDataScienceAnalytics	Amazon	12/3/2024	12/6/2024	Morning	FullTime	2	86000.00
JPosting3	InnovationConsultant	BellCanada	12/3/2024	12/6/2024	Morning	FullTime	1	60000.00
JPosting4	FinancialServicesQualityAssuranceSpecialist	BankOfMontreal	12/3/2024	12/6/2024	Morning	FullTime	2	64628.00
JPosting5	HealthProjectManager	Enbridge	12/3/2024	12/6/2024	Morning	FullTime	1	81563.00
JPosting6	DataAnalystDataScienceAnalytics	Amazon	12/3/2024	12/6/2024	Morning	FullTime	1	87248.00
JPosting7	DigitalSecurityAnalyst	Scotiabank	12/3/2024	12/6/2024	Morning	FullTime	1	90000.00
JPosting8	AgileTransformationCoach	IBM	12/3/2024	12/6/2024	Morning	FullTime	1	145028.00
JPosting9	FinancialServicesEnterpriseArchitect	Amazon	12/3/2024	12/6/2024	Morning	FullTime	2	114253.00

It should be noted that job seekers, location and organization instances data are not part of the BTM jobs data, but they are included for the purpose of matching specifically job seekers' data. As introduced earlier in this chapter, the considered matching and evaluation criteria are education field 1, education field 2, education level, experience field 1, experience field 2, experience years as well as technical skills and soft skills. The reason for considering only these criteria is that they represent the main criteria used in evaluating job seekers. Other criteria such as training certificates and language can be similarly considered.

After composing the data in the Excel file, the data is then imported into the ontology using Protégé Create axioms from Excel Workbook feature located in Tools menu, as shown in Figure 35.

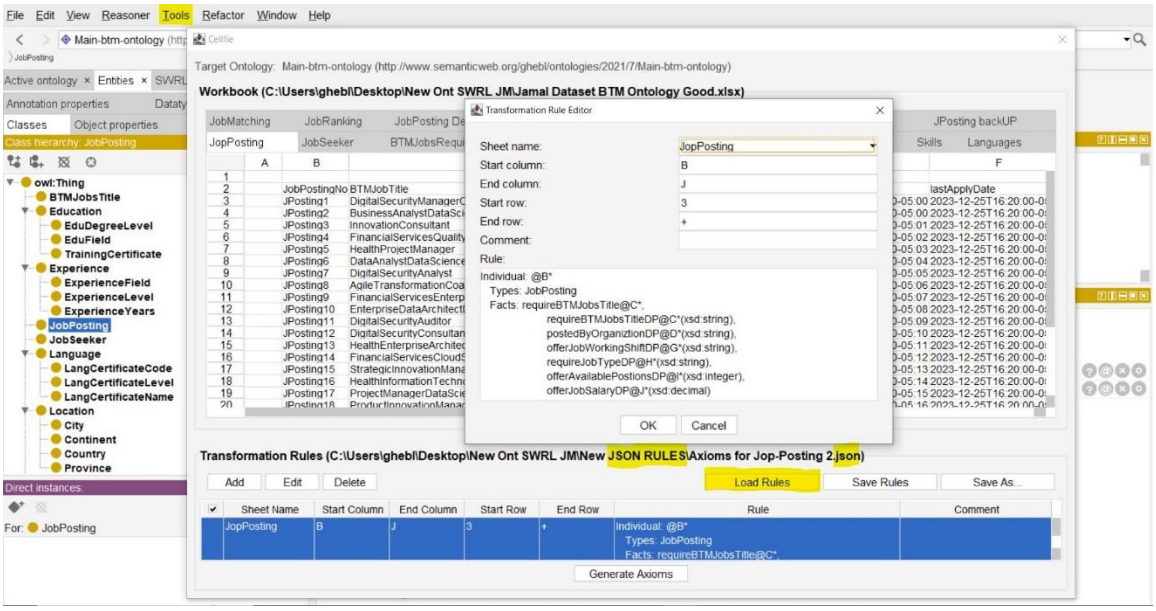

Figure 35 A JSON File for Defining Import Rules in Protégé

This Protégé feature allows to generate a JSON file defining rules that handle the import into the ontology. The following Table 22 shows an example of a JSON file that is used to import job postings data from the Excel file.

Table 22 JSON Import Rules Example

```
{
    "Collections": [{
            "active": true,
            "comment": "",
            "endColumn": "J",
            "endRow": "+",
            "rule": "Individual: @B*\n   Types: JobPosting\n   Facts:
requireBTMJobsTitle@C*,
\n\trequireBTMJobsTitleDP@C*(xsd:string),\n\tpostedByOrganiztionDP@D*(x
sd:string),\n\tofferJobWorkingShiftDP@G*(xsd:string),\n\trequireJobType
DP@H*(xsd:string),\n\tofferAvailablePostionsDP@I*(xsd:integer),\n\toffe
rJobSalaryDP@J*(xsd:decimal)",
            "sheetName": "JopPosting",
            "startColumn": "B",
            "startRow": "3"
        }
    ]
}
```

6.3 BTM Jobs Ontology Matching Results

Unlike existing similar approaches for jobs and job seekers matching and evaluation [100], [101], [102], [103], the use of SWRL in this research is recognized. Moreover, the developed matching method accurately matches (27) jobs with their corresponding job seekers (160 in total). Furthermore, education, experience and skills are well-known criteria used to evaluate applicants. This thesis refines these criteria by considering sub-criteria of two experience and education fields as well as separating the skills criteria into tech and soft skills criteria each with its own evaluation based on job types whether technical or managerial. In addition to SWRL, this research integrates SAW methods as a means of evaluating job seekers based on the specified selection criteria. In this context, several studies use MCDMC methods including SAW for personnel selection [47], [54], [55], [56], [57]. The following Table 23 provides a brief comparison between the thesis approach and alike research which were discussed in detail Chapter 5.

Table 23 Comparing Thesis Matching Approach with Similar Approaches

	BTM Jobs Ontology Matching	**Skill matching algorithms** [100]	**Job-Candidate matching** [101]	**Semantic matching for job recruitment** [102]	**Elastic matching for electronic recruitment** [103]
Context	BTM jobs and job seekers ontology matching	Skills ontology matching.	ESCO ontology for CVs and job matching.	Job recruitment hybrid ontology-based approach	Electronic ontology recruitment
Technique	SWRL rules for reasoning, selection, and matching embedding SAW MCDM method for evaluation	- Semantic similarity metric algorithms	- Similarity matching applied using C# .Net Framework, JSON Parser, ASP .Net, SQL DB to handle frontend and backend operations	- OWL-DL matching and similarity measures ranking	- Distance based semantic similarity with AHP MCDM method for skills matching and evaluation
Limitation	- Weights and Maximum values are hard coded in the rules - No other means of querying results than reasoner inferred facts as well as saving in a DB - Results are grouped under each job seeker but not under each job - No use of standard 5-star rating	- Computationally expensive - Unidirectional algorithm - Domain expert dependent	- 19.12% average matching error.	- Challenges in competency completeness and accuracy	- Incomplete skills details handling. - Application specific.
Advantages	- Refines matching and evaluation criteria by considering fine-grained sub-criteria - Uses unified set of technologies and tools - Integrates jobs and job seekers instances in one ontology for seamless and flexible matching - uses F1-measure analysis to verify results accuracy - High matching and evaluation accuracy	- Efficient skill matching with “nice-to-have” vs. “must-have” optimization - Adaptable to ontology changes	- Automates CV-job matching/ranking - Supports non-exact and multi-criteria matching - Validated by IT jobs experts	- Enhanced precision and recall - Supports qualitative and quantitative reasoning - Includes “must-have” requirements for initial matching and “desires” for ranking	- Automates skills matching with high accuracy reducing manual CVs revie

The following sections discuss the results obtained from implementing the introduced thesis ontology matching and evaluation approach.

6.3.1 Matching and Evaluation Results Overview

Based on the identified criteria and SAW principles, 66 SWRL matching, and evaluation rules are implemented. The Protégé editor used in this research provides the SWRL editor that allows to add, edit and run the rules. The SWRL rules are tightly integrated with Protégé OWL ontology, reasoners especially Pellet as well as Drools rule engine as follows: (1) SWRL rules can directly reference OWL classes, and properties, (2) SWRL rules can be executed directly by starting the Pellet reasoners which infers the rules' results, (3) SWRL rules can be run from the SWRL editor (SWRLTab) which provides a bridge between SWRL, OWL and Drools rule engine enabling storing new inferred facts in the ontology.

The matching and evaluation results are obtained in the Protégé editor using two methods. The first method combines SWRL with the Pellet reasoner whereas the second method uses SWRLTab which allows to bridge with the Drools rule engine and store the results in the ontology. Using either method, SWRL rules need to be add in the Protégé editor using SWRLTab, as shown in the following Figure 36.

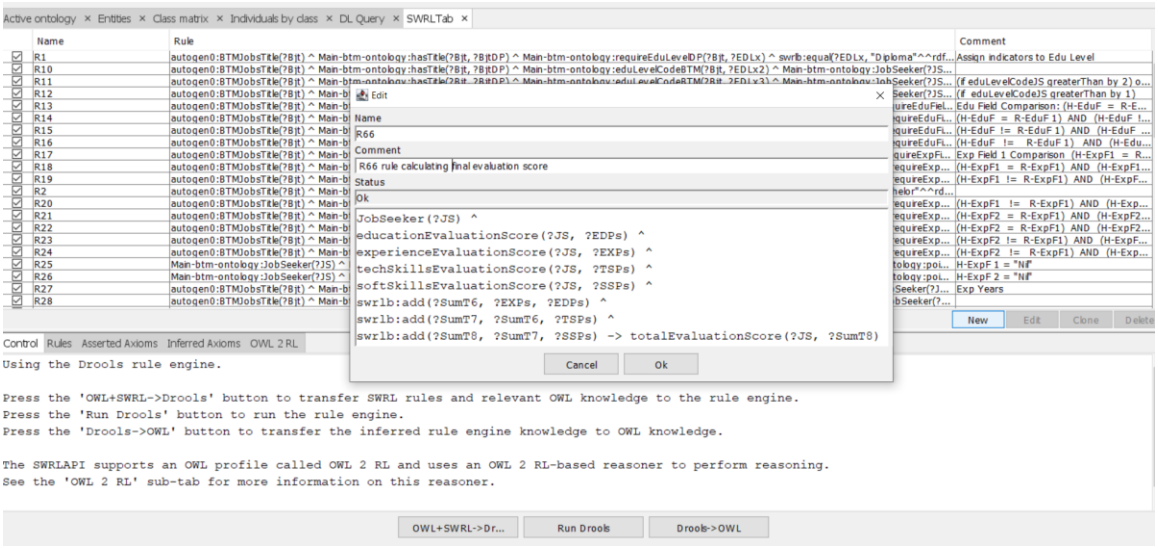

Figure 36 Adding SWRL Rules in Protégé

6.3.2 Running SWRL Rules using Pellet Reasoner

To ensure best and comprehensive SWRL-Pellet results, the Pellet reasoner requires some configurations from the Protégé preference options, as shown in Figure 37.

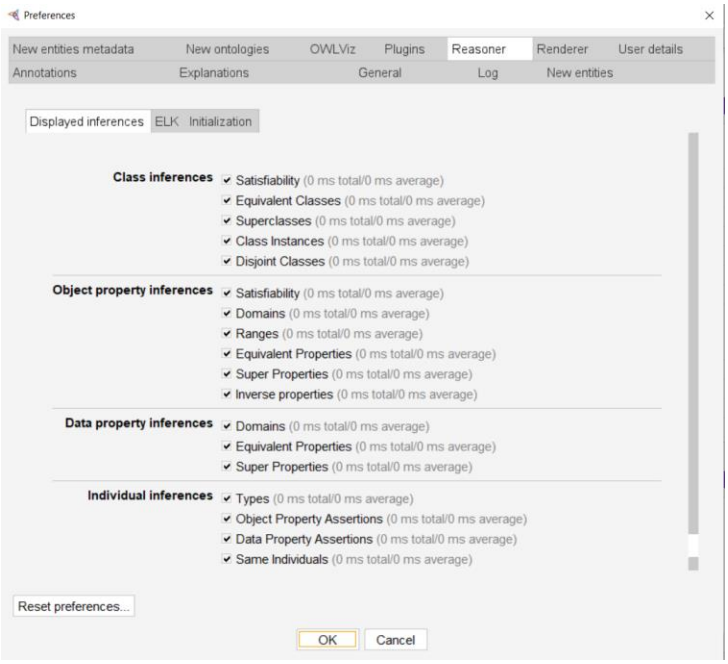

Figure 37 Protege Resoner Preferences

After adding the SWRL rules, the Pellet reasoner can be started, as shown in Figure 38.

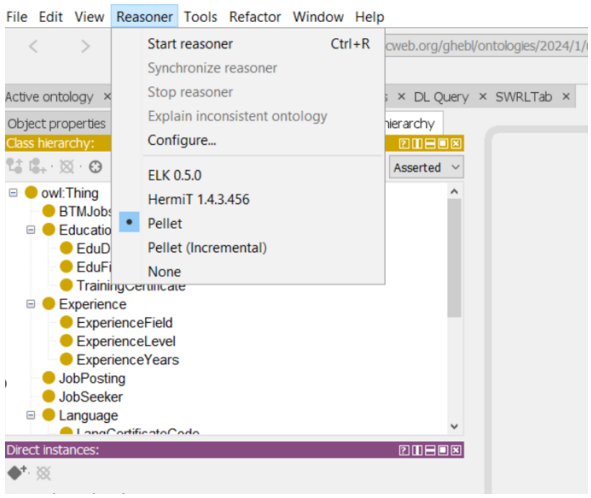

Figure 38 Starting Pellet Reasoner

6.3.3 Matching and Evaluation Results Example

Upon running the Pellet reasoner, the SWRL rules results are inferred. Figure 39 and Figure 40 show an example of the inferred rules results.

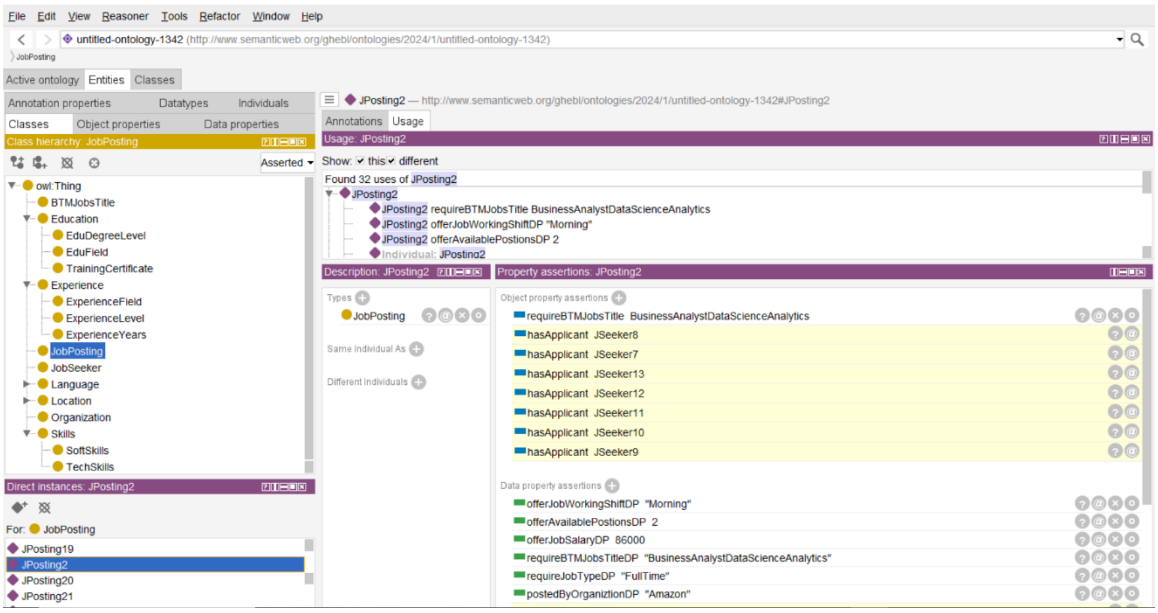

Figure 39 SWRL Rules Results for Matching JobPosting2 with its Job Seekers

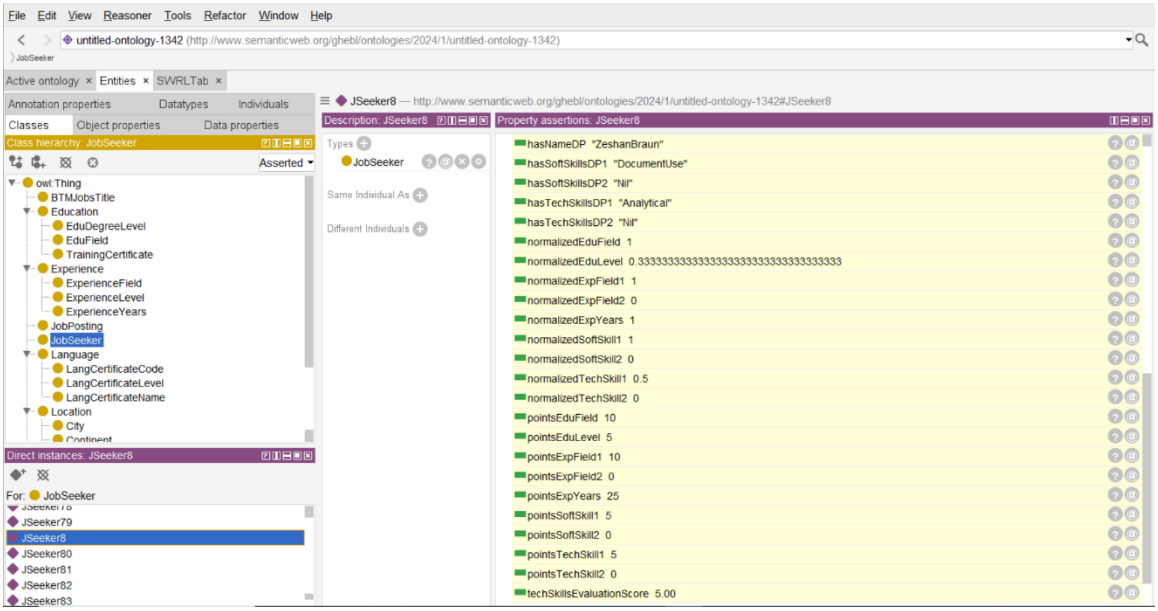

Figure 40 SWRL Rules Results for Matching and Evaluating Job Seeker 8

Based on the actual BTM jobs data, 7 job seekers applied to Business Analyst Data Science Analytics job (JPosting2). As shown in Figure 39, the rules result accurately matched these job seekers with this corresponding job. Similarly, all other jobs instances are correctly matched with their corresponding job seekers instances. Moreover, Figure 40 shows the SWRL rules' results of matching and evaluating JobSeeker8 based on the specified criteria and SAW method.

To further explain the given example, Figure 41 shows the requirements of a Business Analyst Data Science Analytics job, whereas Figure 42 shows the qualifications of Job Seeker 8 (JSeekr8).

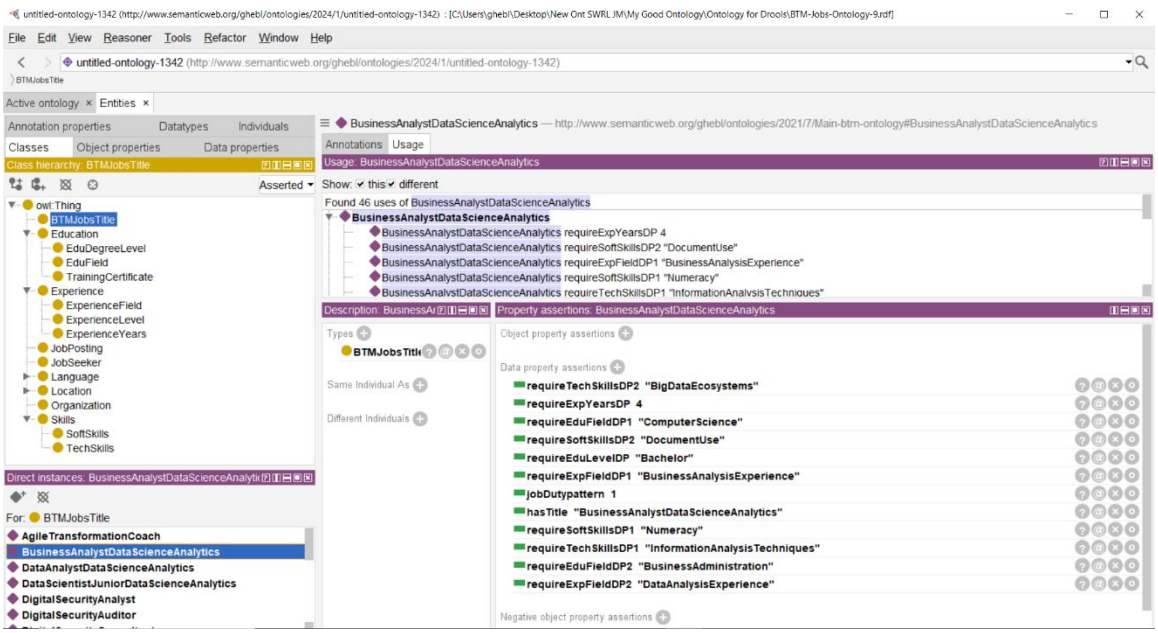

Figure 41 Business Analyst Data Science Analytics Requirements Facts

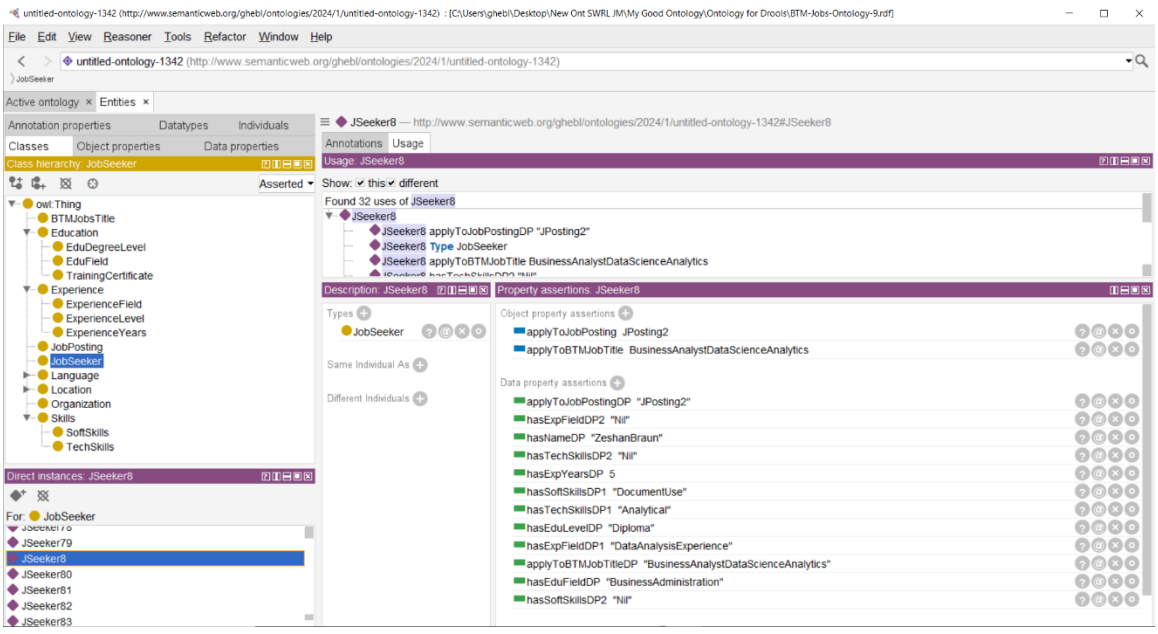

Figure 42 Job Seeker 8 Qualifications

Furthermore, Table 24 (1a), and Table 25 (1b) show the requirements of Business Analyst Data Science Analytics job (JPosting2) along with the qualifications of its 7 matched jobs seekers

(JSeekr7, JSeekr8, JSeekr9, JSeekr10, JSeekr11, JSeekr12, and JSeekr13). The data shown in the following tables represent the actual facts modeled in the developed BTM jobs ontology.

Table 24 Job Posting 2 Requirements and its 7 Job Seekers Qualifications (1a)

	Business Analyst Data Science Analytics (JPosting2)	**Job Seeker 7**	**Job Seeker 8**	**Job Seeker 9**	**Job Seeker 10**
Education Field1	Computer Science	Computing And ≠ Information Science	Business √ Administration	Computer Science √	Information ≠ Technology
Education Field2	Business Administration				
Education Level	Bachelor	Bachelor √	Diploma <	Bachelor √	Masters > by 1 degree
Experience Field1	Business Analysis	IT Service ≠ Management	Data Analysis √	Business Analysis √	Information ≠ Technology
Experience Field2	Data Analysis	Technical Project ≠ Management	Nil	Data Analysis √	Business Analysis √
Experience Years	4 years	3 years <	5 >	3 <	4 =
Technical Skills1	Information Analysis Techniques	Business Analysis Techniques ≠	Analytical ≠	Information √ Analysis Techniques	Technical Problem ≠ Solving
Technical Skills2	Big Data Ecosystems	Big Data √ Ecosystems	Nil	Big Data √ Ecosystems	Cost Benefit ≠ Analysis
Soft Skills1	Numeracy	Reading Text ≠	Document Use √	Numeracy √	Supervision Skills ≠
Soft Skills2	Document Use	Research Skills ≠	Nil	Document Use √	Numeracy √
≠ indicates a mismatch, √ indicates a match					

Table 25 Job Posting 2 Requirements and its 7 Job Seekers Qualifications (1b)

	Business Analyst Data Science Analytics (JPosting2)	**Job Seeker 11**	**Job Seeker 12**	**Job Seeker 13**
Education Field1	Computer Science	Business √ Administration	Computer Science √	Business Technology ≠ Management
Education Field2	Business Administration			
Education Level	Bachelor	Bachelor √	Doctorate > by 2 degrees	Bachelor √
Experience Field1	Business Analysis	Business Processes ≠	Business Analysis √	Nil
Experience Field2	Data Analysis	Nil	Data Analysis √	Nil
Experience Years	4	1 <	3 <	0
Technical Skills1	Information Analysis Techniques	Business Casing ≠	Information Analysis √ Techniques	Project Management ≠
Technical Skills2	Big Data Ecosystems	Nil	Big Data Ecosystems √	Nil
Soft Skills1	Numeracy	Strategic Thinker ≠ Leadership	Numeracy √	Prioritization ≠
Soft Skills2	Document Use	Nil	Document Use √	Adaptability ≠

Based on the facts shown in the above tables, the results of the matching rules (R1-R16), (R20-R33), (R38-R47), and (R52-R61) that assign points to Job Seekers who applied to Job Posting 2 are shown in the following Table 26 and also found in Appendix H.

Table 26 Points Results of Job Seekers Applied to Job Posting 2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker7	5	15	5	5	5	5	10	2	2
Job Seeker 8	10	5	10	0	25	5	0	5	0
Job Seeker9	10	15	10	10	5	10	10	5	5
Job Seeker10	5	10	5	10	20	5	5	2	5
Job Seeker11	10	15	5	0	5	5	0	2	0
Job Seeker12	10	5	10	10	5	10	10	5	5
Job Seeker13	5	15	0	0	0	5	0	2	2

The points shown on Table 26 are calculated based on the introduced matching and evaluation approach in the previous Chapter 5.

6.3.3.1 Education Points Matching and Evaluation Results

Based on the implemented rules, Job Seeker8, Job Seeker9, Job Seeker11, and Job Seeker12 received 10 points in the education field criteria because their education field matched with one of the job required fields (Computer Science or Business Administration). On the other hand, Job Seeker7, Job Seeker10, and Job Seeker13 received only 5 points as their education field mismatched the job required fields. These results correctly confirm to the real facts presented in Table 24 (1a) and Table 25 (1b). The points assignments are specifically determined by the rules R13-R16, introduced, and explained in Chapter 5.

Moreover, the education level calculated points are 5, 10, and 15 points, as shown on the above Table 26. The variation in these points is due to a more detailed evaluation process implemented in the approach as follows. Job Seeker7, Job Seeker9, Job Seeker11 and Job Seeker13 received 15 points as their education level exactly matched the required level. Because Job Seeker10 education level exceeded the required level by one degree, it is assigned 10 points. However, Job Seeker8 obtained 5 points since their education level is lower than the required level. Also, Job Seeker12 received 5 points because their education level exceeded the required level by two degrees making them overqualified. These points results are calculated specifically from R9-R12 rules.

6.3.3.2 Experience Points Matching and Evaluation Results

The points for experience fields shown in Table 26 are assigned based on the criteria explained in Chapter 5. Following the same results example, Job Seeker8, Job Seeker9, and Job Seeker12 received 10 points in the experience field 1 because their experience matched one of the required experience fields. Moreover, Job Seeker7, Job Seeker10, Job Seeker11 obtained 5 points due to a

mismatch with both required fields while Job Seeker13 obtained 0 for lacking any experience. The same matching and evaluation process applies to experience field 2. These results were determined by the R20-R29 rules which were explained in detail in Chapter 5.

Continuing with the assessment of experience points, the criteria for years of experience entail four scenarios as follows. (1) If a job seekers experience years align precisely with the jobs required experience, they are awarded 20 points. This is exemplified by Job Seeker10. (2) If the job seeker possesses more experience years than required, they receive 25 points, as evidenced by Job Seeker8. (3) Job seekers with fewer experience years than required are allocated 5 points. This applies to Job Seeker7, Job Seeker9, Job Seeker11, and Job Seeker12. (4) Job Seeker13 receives 0 points due to a lack of any experience years. These results are determined by R30-R33 rules.

6.3.3.3 Technical Skills Points Matching and Evaluation Results

Technical skill 1 and technical skill 2 follow the same points assignment process such that when a match is made with either of the required technical skills, 10 points are assigned. This can be seen in the case of Job seeker7, Job seeker9 and Job seeker12 who received 10 points in technical skill 2. On the other hand, if technical skills of a job seeker do not match both required technical skills, 5 points are assigned, as the case with Job seeker10. In cases of missing technical skills, a job seeker is given 0, as demonstrated in Job seeker8, Job seeker11, and Job seeker13 results. The above points were obtained by applying the R38-R47 rules introduced in Chapter 5.

6.3.3.4 Soft Skills Points Matching and Evaluation Results

As with technical skills, soft skill 1 and soft skill 2 use the same points assignment process so that when a match is made with either of the required soft skills, 5 points are assigned. For instance, considering soft skill 2, the highest points of 5 were assigned to Job seeker9, Job seeker10, and Job seeker12 due to their exact match with the required soft skill 2. In contrast, Job seeker7 and Job seeker13 received 2 points due to their mismatch with both required soft skills. Job seeker8 and Job seeker11 on the other hand are lacking any soft skills, thus they obtained 0 in points. These points are determined by the R52-R61 rules explained in Chapter 5.

6.3.3.5 Points Normalization

The previous points matchings, and assignments are the first step in the evaluation process. These points are then normalized using the SAW normalization formula (1) integrated in the SWRL rules (R17-R18), (R34-R36), (R48-R49), and (R62-R63) as explained in detail in Chapter 5.

$$r_{ij} = \frac{x_{ij}}{max_i\, x_{ij}} \qquad (1)$$

From SAW formula (1), the normalization process involves dividing each criterion's points by its corresponding maximum. Table 27 shows the maximum points for each criterion.

Table 27 Criteria Maximum Points

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Maximum Points	10	15	10	10	25	10	10	5	5

Based on the previous example, Table 28 shows the normalized points for each criterion associated with job seekers who applied to Job Posting 2.

Table 28 Normalized Results of Job Seekers Applied to Job Posting 2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker7	0.50	1.00	0.50	0.50	0.20	0.50	1.00	0.40	0.40
Job Seeker 8	1.00	0.33	1.00	0.00	1.00	0.50	0.00	1.00	0.00
Job Seeker9	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker10	0.50	0.67	0.50	1.00	0.80	0.50	0.50	0.40	1.00
Job Seeker11	1.00	1.00	0.50	0.00	0.20	0.50	0.00	0.40	0.00
Job Seeker12	1.00	0.33	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker13	0.50	1.00	0.00	0.00	0.00	0.50	0.00	0.40	0.40

From Table 28, it can be seen, for instance, the normalized points of Job Seeker7 in the Education field is 0.50, as a result of dividing the points (5) by the corresponding maximum (10). All other normalized points are similarly calculated by such SAW normalization processes.

6.3.3.6 Total Score Calculation

The previous normalized points need to be weighted according to SAW formula (2) which is integrated in the SWRL rules R19, R37, R50, R51, R64, R65, and R66 as explained in detail in Chapter 5.

$$V_i = \sum_{j=1}^{n} w_i\, r_{ij} \qquad (2)$$

SAW formula (2) involves multiplying each normalized point with its corresponding weight. Table 29 shows the weight for each criterion.

Table 29 Criteria Weights

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Technical Jobs Weights	0.100	0.150	0.100	0.100	0.250	0.100	0.100	0.050	0.050
Management Jobs Weights	0.100	0.150	0.100	0.100	0.250	0.050	0.050	0.100	0.100

Then, the multiplied results are summed up to obtain the overall score for each criteria category as shown in Table 30.

Table 30 Criteria Scores and Total Score Example

	Education Score	Experience Score	Technical Skills Score	Soft Skills Score	Total Score
Job Seeker7	20.00	15.00	15.00	4.00	54.00
Job Seeker 8	15.00	35.00	5.00	5.00	60.00
Job Seeker9	25.00	25.00	20.00	10.00	**80.00**
Job Seeker10	15.00	35.00	10.00	7.00	67.00
Job Seeker11	25.00	10.00	5.00	2.00	42.00
Job Seeker12	14.95	25.00	20.00	10.00	69.95
Job Seeker13	20.00	0.00	5.00	4.00	29.00

The scores shown in Table 30 are in percentages and represent the evaluation of job seekers who applied to Job Posting 2. Since Job Posting 2 is a technical job "Business Analyst Data Science Analytics", the matching and evaluation rules correctly identified and applied weights of 0.100 and 0.050 for technical and soft skills respectively. For example, Job Seeker 7 scores 20.00%. in technical skills and XX% in soft skills calculated by the rules based on SAW formula (2) as follows:

Technical Skills Score **=** ((Technical Skill 1 weight **x** Technical Skill 1 points) **+** (Technical Skill 2 weight **x** Technical Skill 2 points)) **x** 100.

Technical Skills Score **=** ((0.50 **x** 0.10) **+** (1.00 **x** 0.10)) **x** 100 **=** (0.05 **+** 0.10) **x** 100 **=** 15.00%.

Soft Skills Score **=** ((Soft Skill 1 weight **x** Soft Skill 1 points) **+** (Soft Skill 2 weight **x** Soft Skill 2 points)) **x** 100.

Soft Skills Score **=** ((0.40 **x** 0.05) **+** (0.40 **x** 0.05)) **x** 100 **=** (0.02 **+** 0.02) **x** 100 **=** 4.00%

Other criteria scores are similarly calculated.

Finally, since the calculated points are normalized and weighted according to SAW method, the Total score is obtained from the R66 rule by summing up the criteria scores for each job seeker, as shown in the previous Table 30. It can be noted from Table 30 that Job Seeker 9 scored the highest

total score of 80.00%. Therefore, Job Seeker 9 represents the best candidate (alternative) for the Job Posting 2 followed by Job Seeker 12 with 69.95% total score and then Job Seeker 10 with 67.00% total score. It should be mentioned that using Pellet reasoner as in the previous example allows to obtain the inferred results however, these results are not saved in the ontology. To save the results in the ontology, SWRL rules are run using SWRLTab which involves running the Drools engine as shown in the following Figure 43.

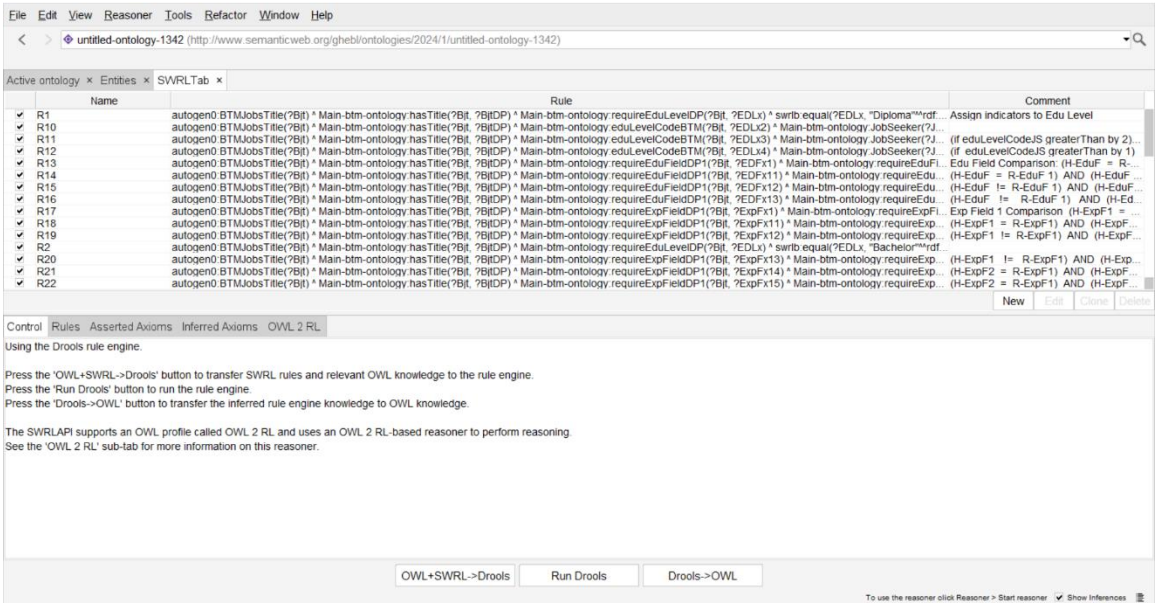

Figure 43 Drools Engine

Moreover, it was observed that using SWRL rules and Drools engine produced identical results to those demonstrated in the preceding example using the Pellet reasoner. Figure 44 shows an example of the results of running SWRL rules alongside with the Drools Engine.

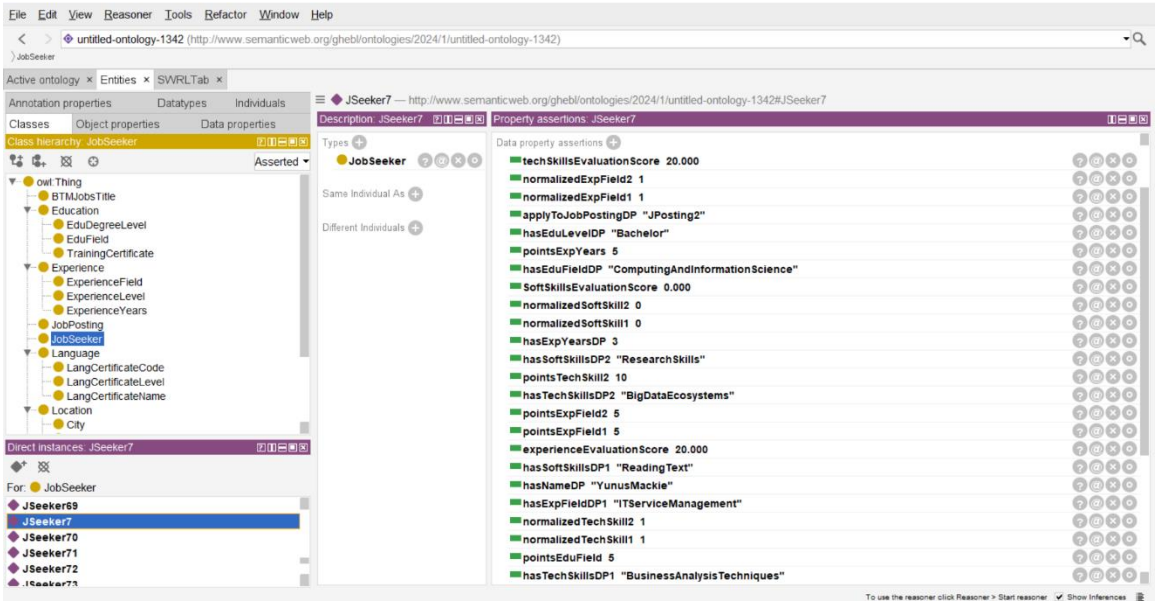

Figure 44 Results of Using Drools Engine in Conjunction with SWRL Rules

Likewise, it was found that running SWRL rules, Drools engine and saving the results in the ontology prevents subsequent running using this method as the resulted facts are already stored in the ontology. Such limitation is further explained by Michael DeBellis[20].

6.4 Evaluating Results Accuracy Using F-measure

The matching and evaluation results as presented in the previous sections were obtained using two methods: SWRL with Pellet reasoner and SWRL with Drools engine both incorporating the use of SAW. These two methods produced identical results. To further validate the accuracy of the results, F-measure is used as follows: F-measure involves the use of precision and recall concept. Precision evaluates the level of correctness of the results while recall measures the degree of completeness of the results. F-measure, then, allows to calculate a single measure based on precision and recall. More importantly, it compensates higher recall and lower precision or vice versa situations [91]. Precision, Recall and F-measure are computed as shown on the following expressions:

$$\text{Precision} = \frac{\text{correct correspondences}}{\text{total returned correspondences}}$$

$$\text{Recall} = \frac{\text{correct correspondences}}{\text{expected correspondences}}$$

$$\text{F} - \text{measure} = \frac{2 \text{ X Precision X Recall}}{\text{Precision+Recall}}$$

[20] https://www.michaeldebellis.com/post/drools-vs-pellet-for-swrl-rules

F-measure is applied to various obtained results. For instance, Table 31 shows the matching of job seekers who applied to Job Posting 2 produced correct results with 100% accuracy.

Table 31 Accuracy of Matching Job Posting 2 with its Corresponding Job Seekers

Job Posting 2	
Job Seekers	
Applied (expected correspondences)	**Matched (total returned correspondences)**
Job Seeker7	Job Seeker7
Job Seeker 8	Job Seeker 8
Job Seeker9	Job Seeker9
Job Seeker10	Job Seeker10
Job Seeker11	Job Seeker11
Job Seeker12	Job Seeker12
Job Seeker13	Job Seeker13
Accuracy	100%

Table 31 shows that the correct correspondences are equal to the total returned correspondences as well as to the expected correspondences. In other words, the 7 job seekers who applied to Job Posting 2 based on the actual data are accurately matched to Job Posting 2 by the implemented SWRL rules. Therefore, applying Precision, Recall and F-measure results in the following accuracy:

$$\text{Precision} = \frac{\text{correct correspondences}}{\text{total returned correspondences}} = \frac{7}{7} = 1$$

$$\text{Recall} = \frac{\text{correct correspondences}}{\text{expected correspondences}} = \frac{7}{7} = 1$$

$$\text{F} - \text{measure} = \frac{2 \text{ X Precision X Recall}}{\text{Precision+Recall}} = \frac{(2 \text{ x } 1 \text{ x } 1)}{(1+1)} = 1$$

Similarly, the following Table 32 shows the expected correspondences and the total obtained or returned correspondences for education field and level matching as well as education score matching and evaluation for each job seeker matched with Job Posting 2.

Table 32 Accuracy of Education Criteria Matching & Evaluation for Job Seekers in Job Posting 2

	Education Field Matching		**Education Level Matching**		**Education Score Matching and Evaluation**	
	Points		**Points**			
	Expected	**Returned**	**Expected**	**Returned**	**Expected**	**Returned**
Job Seeker7	5	5	15	15	20.00	20.00
Job Seeker 8	10	10	5	5	15.00	15.00

	Education Field Matching		Education Level Matching		Education Score Matching and Evaluation	
	Points		Points			
	Expected	Returned	Expected	Returned	Expected	Returned
Job Seeker9	10	10	15	15	25.00	25.00
Job Seeker10	5	5	10	10	15.00	15.00
Job Seeker11	10	10	15	15	25.00	25.00
Job Seeker12	10	10	5	5	14.95	14.95
Job Seeker13	5	5	15	15	20.00	20.00
Accuracy	100%		100%		100%	

It can be seen from Table 32 that the expected and obtained results for each job seeker are identical, thus the accuracy of the results in the education field and level points as well as the education score is 100%. It is evident that applying F-measure will result in 1 similar to the previous one. Following the same concept of comparing the expected results and the obtained results as well as calculating F-measure, Table 33, Table 34, and Table 35 show the accuracy of 100% for Experience Field 1, Experience Field 2, Experience Years, Technical Skills and Soft Skills.

Table 33 Accuracy of Experience Criteria Matching & Evaluation for Job Seekers in Job Posting 2

	Experience Field 1 Matching		Experience Field 2 Matching		Experience Years Matching		Experience Score Matching and Evaluation	
	Points		Points		Points			
	Expected	Returned	Expected	Returned	Expected	Returned	Expected	Returned
Job Seeker7	5	5	5	5	5	5	15.00	15.00
Job Seeker 8	10	10	0	0	25	25	35.00	35.00
Job Seeker9	10	10	10	10	5	5	25.00	25.00
Job Seeker10	5	5	10	10	20	20	35.00	35.00
Job Seeker11	5	5	0	0	5	5	10.00	10.00
Job Seeker12	10	10	10	10	5	5	25.00	25.00
Job Seeker13	0	0	0	0	0	0	0.00	0.00
Accuracy	100%		100%		100%		100%	

Table 34 Accuracy of Tech Skills Criteria Matching & Evaluation for Job Seekers in Job Posting 2

	Technical Skill 1 Matching		Technical Skill 2 Matching		Technical Skills Score Matching and Evaluation	
	Points		Points			
	Expected	Returned	Expected	Returned	Expected	Returned
Job Seeker7	5	5	10	10	15.00	15.00
Job Seeker 8	5	5	0	0	5.00	5.00
Job Seeker9	10	10	10	10	20.00	20.00
Job Seeker10	5	5	5	5	10.00	10.00

	Technical Skill 1 Matching		Technical Skill 2 Matching		Technical Skills Score Matching and Evaluation	
	Points		Points			
	Expected	Returned	Expected	Returned	Expected	Returned
Job Seeker11	5	5	0	0	5.00	5.00
Job Seeker12	10	10	10	10	20.00	20.00
Job Seeker13	5	5	0	0	5.00	5.00
Accuracy	100%		100%		100%	

Table 35 Accuracy of Soft Skills Criteria Matching & Evaluation for Job Seekers in Job Posting 2

	Soft Skill 1 Matching		Soft Skill 2 Matching		Soft Skills Score Matching and Evaluation	
	Points		Points			
	Expected	Returned	Expected	Returned	Expected	Returned
Job Seeker7	2	2	2	2	4.00	4.00
Job Seeker 8	5	5	0	0	5.00	5.00
Job Seeker9	5	5	5	5	10.00	10.00
Job Seeker10	2	2	5	5	7.00	7.00
Job Seeker11	2	2	0	0	2.00	2.00
Job Seeker12	5	5	5	5	10.00	10.00
Job Seeker13	2	2	2	2	4.00	4.00
Accuracy	100%		100%		100%	

The previous tables did not include the comparison expected and obtained results for points normalization and multiplying normalized points with their corresponding weights as these are straightforward calculations based on the points matching and assignments, and it is clearly already verified by the expected and obtained scores.

Chapter 7

Conclusion

7.1 Conclusion

Identifying and selecting the right candidate for the right job is challenging. It requires developing innovative approaches that provide automated matching, evaluation with high accuracy and transparency as well as improved reusability and scalability.

This thesis introduced a systematic ontology-based approach to match and evaluate applicants' qualifications against corresponding job requirements addressing a common challenge in recruitment and selection processes. The introduced approach combines rules matchmaking with the multi criteria evaluation method.

To address the research problem and accomplish its objectives, the thesis reviewed several related studies including main literature in the HRM domain particularly in the context of the recruitment and selection processes, Semantic Web technologies especially OWL, SWRL and their underlying DL theory as well as ontology matching approaches, and ontology development practices and methodologies particularly METHONTOLOGY, MCDM concepts focusing on the SAW method, and BTM domain background with its jobs dataset collection and analysis. Moreover, the thesis compared its approach with existing similar approaches. Then, the approach implementation and results were discussed in detail.

Based on the BTM jobs dataset, the research developed BTM jobs and job seekers ontology to enhance the efficiency, accuracy, automation, and interoperability of matching job requirements with applicant qualifications featuring as the first research work in the BTM domain. The core of the research involved the development of a BTM jobs-applicants OWL ontology using Protégé ontology editor with the matching and evaluation technique using SWRL rules integrating SAW evaluation based on the predefined criteria. The ontology development was based on the METHONTOLOGY methodology to ensure compliance with best practices in ontology engineering. This enables the establishment of a structured domain knowledge representation, which was critical for the subsequent matching and evaluation phases. The SWRL was found to be effective and simple in defining rules that efficiently matched and evaluated the qualifications of applicants against job requirements. Likewise, the integration of the SAW in the rules provided a

straightforward and enhanced assessment method enabling a more accurate evaluation process and results.

Moreover, the research demonstrated the feasibility and effectiveness of the Semantic Web technologies in addressing personnel selection challenges with improved reusability. This unified semantic framework enabled enhanced automation, transparency and precision in the applicant's selection process leading to saving time and cost while simultaneously improving decision-making quality.

In addition to the direct contributions to the BTM domain, the ongoing effort of developing a comprehensive standardized BTM BOK can benefit from the results and the analysis of this research for further improvements and integrations. Moreover, the significance of this research extends to its novel utilization of the SWRL rules in the HRM selection process. It sets the necessary foundations for future research and application by providing a flexible model that can be adapted and extended to other job domains with minor changes, thus emphasizing the potential for reusability and scalability.

In short, this thesis provides notable work in the context of HRM recruitment and selection processes advancing related literature and participating in businesses success and growth. It not only provides a robust approach for the effective matching of job requirements with applicant qualifications but also lays the groundwork for future improvements in HRM and related fields. The progress from concept to implementation, guided by a structured methodology, advanced technologies, and empirical validation, encapsulates the thesis's comprehensive approach to addressing complex challenges in the context of HRM recruitment selection processes.

7.2 Findings

The findings of this thesis support the innovative application of Semantic Web technologies, particularly OWL ontologies and SWRL matching rules combined with the MCDM SAW method in the domain of HRM recruitment and selection processes. The integration of these technologies revealed several insights including:

1- The empirical validation using F-measure accuracy analysis resulted in high precision and recall. Thus, these accurate results not only confirm the effectiveness and reliability of the approach but also highlight its practical application in automating and enhancing HRM recruitment processes.

2- The use of ontologies in general and the Protégé editor in particular provides critical advantages in ensuring the consistency of the concepts and properties. This feature is important in HRM where the consistency of job requirements and applicant qualifications is critical. The Protégé and its reasoners plugins consistency checks prevent inconsistent assertions, hence enhancing the reliability of ontology modeling.

3- By relating job requirements and applicants' qualifications within the same ontology through properties and using the abilities of built in reasoning, the approach enables straightforward matching and evaluation of multiple jobs and applicants simultaneously.

4- The straightforward yet powerful syntax of SWRL rules combined with the easiness of the SAW facilitate the effective evaluation of candidates.

5- The Protégé built-in integration of SWRL with the Pellet reasoner demonstrated seamless process of reasoning and inferring new facts based on the specified properties and rules.

6- The Semantic Web Open-World Assumption (OWA) operates on the principle that the absence of information does not imply its negation. This indicates that if “something” is not known to be true, it is not automatically considered false. Moreover, the monotonic nature of SWRL implies that rules results can not be changed when saved in the same ontology using Drools engine. While this ensures logical consistency, it restricts flexibility especially considering dynamic systems and implies using external saving means rather than saving in the same ontology.

7- A notable technical challenge encountered involved the integration of SWRL with the Drools engine, particularly regarding data property types. The issue of data type serialization, especially with string data types, prevented successive execution of SWRL rules within the Drools engine, leading to exceptions and errors. The Drools engine requires explicit declaration of data types while the string data type is not explicitly serialized in Protégé ontology formats.

These findings highlight both the potential and challenges of applying Semantic Web technologies in the HRM context. While the ontology-based approach significantly advances the automation, accuracy, and efficiency of recruitment processes, it also highlights critical aspects of Semantic Web technologies when used with systems that require dynamic changes of assertions or facts.

7.3 Limitation

This research provided significant insights and advancements in the domain of HRM recruitment using Semantic Web technologies. Similar to most studies and also due to time constraints, the research faced certain limitations. One notable limitation is the reliance on the Protégé desktop environment for the development and testing of the ontology-based matching and evaluation system. Unlike online platforms, the desktop-based environment may limit the scalability and usability of the system.

Another limitation is the scope of matching and evaluation criteria focusing mainly on Education, Experience, and Skills. Other criteria such as training and language proficiency were not considered in the current matching and evaluation rules, however, similar to the used criteria, they can be easily added to the system. Additionally, the criteria weights and maximum values were hardcoded in the rules. Although these values can be changed from the rules, dynamically adjusting the values based on user's feedback or experts' judgment can improve the flexibility of the matching and evaluation system.

Furthermore, the system currently does not include querying specific results beyond using the reasoner inferred rules' results and facts. It does not also include saving results externally, such as in a database. Moreover, the matching and evaluation results are organized and inferred under each job seeker instance rather than grouped by job. This might affect the clarity and usability of the results. The system also lacks the incorporation of a standardized rating system such as a 5-star scale, commonly understood by several practices. Lastly, the ontology and its components are defined solely in English, which may limit accessibility for non-English speakers or multi-lingual applications.

7.4 Future Work

Building upon the work of this research, several directions for future work arise including the following. The ontology concepts can be enhanced by considering integrating related HR standards concepts as well as the creation of APIs for seamless integration. Furthermore, enhancing the set of rules to include additional criteria such as training and language proficiency will improve and fine-tune the evaluation results. Likewise, incorporating dynamic adjustment mechanisms for criteria weights and maximum values within the ontology will lead to a more flexible approach, where variables are defined in the SWRL rules to capture the values for easier adjustments based on feedback from users.

Additionally, exploring methods for external results storage and specific querying capabilities will enhance the flexibility, usability, and performance of the system. One such method could involve the integration of the H2 database with Protégé through the use of Ontop plugin as well as the incorporation of SQWRL and SPARQL queries. Investigating parallel processing techniques or leveraging distributed computing resources is similarly beneficial in terms of handling large scale ontologies.

Finally, deploying the system in real-world scenarios in collaboration with organizations or recruitment agencies could provide invaluable feedback and insights about the effectiveness of the system as well as possible areas of improvements. This enables refining the matching system and enhancing the overall impact on recruitment efficiency and quality. Such deployment can be achieved by developing an online BTM jobs portal enabling improved practicality and scalability of the matching and evaluation system.

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Appendix A

BTM-NOS-ITAC-Jobs

1.0-Appendix A illustrates and explains Business Technology Management (BTM) Financial Services National Occupational Standards (NOS) Jobs.

Created to address the needs of organizations for BTM skills in the financial services area. The Core BTM Baccalaureate Learning Outcomes and Competency Standards have been adjusted to include Financial Services specific items. For instance, Financial services graduates of the program should, in addition to their core BTM skills, be able to exhibit knowledge and expertise in conducting finance related requirements analysis. Graduates of this specialization are expected to perform responsibilities for roles such as:

- Financial Services IT Governance, Risk, and Compliance Manager (GRCM)
- Financial Services Cloud Services Manager
- Financial Services Enterprise Architect
- Financial Services Quality Assurance Specialist
- Financial Services Cyber Security Specialist

1.1 Financial Services IT Governance, Risk, and Compliance Manager (GRCM)

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Accountable for all processes related to IT strategic governance, risk management, and regulatory compliance. Reports to the Chief Information Officer (CIO), acting as primary advisor in governance mechanisms throughout the organization. Manages IT-related risk within the scope of the organization's Enterprise and Operational Risk policies. Primary liaison for all regulatory compliance matters involving IT. Ensures conformity to IT-related policies, standards, regulations, and laws. Supports the IT strategic planning cycle and ensures due diligence in strategy deployment.
Position Development	Advancement to position typically follows at least 15 years of experience within a financial institution
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor degree with a major in Business Technology

	Management (BTM), ideally combined with a graduate certificate in Project Management, as well as a graduate certificate in Regulatory Compliance
Training	Professional certifications provided by ISACA, such as CISA, CGEIT, CRISC, as well as by PMI, such as PMP, RMP, and ACP
Related Work Experience	Risk management or regulatory compliance, with later experience in support to IT governance processes, as well as cybersecurity audit

Tasks	
	• Supports the IT strategic planning cycle and ensures due diligence in strategy deployment.
	  o Develops a set of decision rights and accountability framework for directing, controlling, and executing IT endeavors in order to determine and achieve desired behaviors and results.
	  o Defines the management model and the governing or guiding principles, including: who makes directing, controlling, and executing decisions, and defines the ultimate authority (final arbiter); how the decisions will be made, and the procedures for escalation and arbitration; what information will be required to make the decisions, etc.
	• Manages IT-related risk within the scope of the organization's Enterprise and Operational Risk policies.
	  o Develops Enterprise and Operational Risk policies and criteria, to be used by various IT governance mechanisms.
	  o Conceives a risk management model that allows identification, definition, and assessment of risks, and the implementation and operation of risk mitigation and avoidance activities.

	• Ensures conformity to IT-related policies, standards, regulations, and laws.
	  o Promotes compliance to standards and regulations for which there is a recognized business need.
	  o Analyzes gaps to determine the distance between the current situation and compliance.
	  o Measures the progress of an IT organization in complying with a standard or regulation, using a maturity model.

Tools and Technology	• Thorough knowledge of IT management in financial services • IT governance standards (COBIT, ValIT) • IT strategic management processes • IT service management and performance reporting systems • Regulatory compliance management systems • Project management systems and project portfolio monitoring
Required Competencies	

Knowledge	**Governance**
	• Governance Framework:
	  • Specifying:
	  • Management models
	  • Guiding principles
	  • Policies and standards
	  • Measurement and control approaches, such as CIO dashboard, balanced scorecard
	  • Quality management approaches
	  • Defining critical success factors
	  • Generating a list of decision areas and issues, and selecting decision options based on guiding principles, values, and assumptions

- Responding to any identified gaps between the current baseline and the desired framework
- Communicating direction

- Governance Capabilities:
  - Defining information technology management system requirements and key indicators
  - Building capabilities to realize the specified management models
  - Creating instruments that conform to policies and standards, such as:
    - Methods
    - Measurement and control capabilities
    - Quality management system
    - Continual improvement techniques
  - Organization design in relation to IT, such as:
    - Structure, behaviors, enablers
    - Roles and responsibilities definitions
    - Process structure
    - Implementation or change transition plans, including schedule
- Governance Operations:
  - Measurement and control, such as:
    - Issues management
    - CIO dashboard
    - Balanced scorecard
  - Steering IT workings within the tolerances set by Governance
  - Regulating the execution of IT processes

Risk

- Understanding the operational risk, especially related to financial asset implications from IT and transaction processing, throughout the financial services industry, by product, geography/jurisdictions, and segment (banking, insurance, investment).

- Risk management standards, e.g., ISACA's CRISC, PMI's PRM.
- Risk definition and identification methods
- Risk scoring and modeling, quantitative and qualitative
- Risk response planning harmonized with business continuity planning
- Risk monitoring and consensus building among many disciplines

Compliance

- Understanding the regulatory compliance challenges throughout the financial services industry, by product, geography/jurisdictions, and segment (banking, insurance, investment).
- Consideration of internal and external regulations, standards and legal obligations impacting the business where they could require IT support. For example:
  - Privacy regulations
  - Laws such as Sarbanes Oxley
  - Industry standards and guidelines such as ISO/IEC 17799, COSO and COBIT®
- Specification of compliance controls needed within IT services and solutions and also within other IT processes
- Internal and external audit readiness preparations
- Compliance audits

Skills A person performing this role needs the following skills:

Governance

- Leadership and team-building capabilities
- Thorough experience in the IT governance lifecycle to coach, guide, and support other team members
- Proficiency in conflict resolution and problem-solving techniques
- Good skills in presentation, facilitation, communication, and negotiation

Risk

	• Expertise in identifying and understanding problems and opportunities • Ability to articulate the needs that are associated with the key problem to be solved or the opportunity to be realized • Ability to collaborate effectively with the extended team through collaborative working sessions, workshops, and other techniques. • Good communication skills, verbally and in writing • Knowledge of the business and technology domains or the ability to quickly absorb and understand such information **Compliance** • Good knowledge of the business and regulatory domains • Demonstrate leadership and be respected by external stakeholders (regulatory agencies, auditors, industry bodies) • Make decisions at the right time (not too soon, not too late) • "Open minded" to change, forward looking, strategic mindset • Effective communication skills with the team and outside • Excellent interpretation skills to understand/translate regulatory language into IT and project related goals
Personal Attributes	
Abilities	Position IT and financial professionals as equal partners, finding equilibrium even when a key profession may be dominant within the organization, leveraging IT as enabler of innovative financial products and services, and demonstrating leadership and initiative beyond traditional IT roles.
Work Values	Develop common values with financial professionals from all around the globe, showing respect for the diversity of the financial services industry in different countries, and cultural sensibility in multinational organizations and/or involving international customers, where trust is a key element of service delivery.

Work Styles	Perform tasks diligently under stress, responding positively to criticism from professions with a quantitative approach, keeping focus throughout complex financial services processes, and sharing responsibility for highly critical processes, such as handling financial transactions that may put the organization at risk at any moment.
Essential Skills Profile	
Reading text	
Document use	
Writing skills	
Numeracy	Convince financial professionals by using and/or interpreting quantitative analysis astutely, leading by example in accessing and relying on the best data and most intelligent solutions, with a keen understanding of risk and performance, while creating trust by showing respect towards diverse financial professions.
Oral Communication	Speak the language of financial professionals, with current knowledge of the distinctive strategic and operational challenges of the industry, including such complex issues as quantitative analysis, value-at-risk, service and portfolio performance, regulatory compliance, and competitiveness.
Thinking Skills	
Problem Solving	Translate the multi-facetted benefits of IT in terms of business value, linking direct and indirect impacts on process and enterprise performance in the context of a financial institution, and formulating IT value propositions that fit the value-at-risk decision making framework of different industry segments.
Decision Making	Contribute to IT-related decisions by linking technology, operational, management, and strategic facets, focusing on value-at-risk and performance, while proposing solutions that fit the organization's risk culture, and a concern for the business value of IT from the viewpoint of financial services customers.
Job Task Planning and Organizing	Integrate the best of generic, IT, and industry-specific project management practices and standards, ensuring IT projects remain aligned with the evolving needs of the financial institution and its industry segment, and developing a strong project learning culture for sustained performance improvement.
Significant Use of Memory	

Finding Information	Lead by example in teaching financial professionals how to leverage seamless IT-based communications, especially in organizations with a conservative culture, primarily by demonstrating the value of new technologies, while ensuring keeping organizations human-friendly and ensuring trust and reliability.
Working with Others	Engage both IT and financial professionals to share common goals, exploiting hybrid interpretation skills for addressing the complex interdependencies between technology and financial service, and distinguishing oneself by conceiving innovative solutions that surpass results from traditional approaches.
Continuous Learning	Support learning and change in IT projects throughout the organization, responding diligently to knowledge gaps in projects by staffing the best people and skills, learning how to integrate knowledge from the relevant IT and financial professions, and developing the organizational memory through successive projects.
Additional Information	
Physical Aspects	This position does not involve any exceptional physical aspects
Attitudes	This position does not involve any exceptional attitudes or endurance
Future Trends Affecting Essential Skills	Increased use of automated tools, aided by Artificial Intelligence, will require greater capabilities in using and integrating diverse information sources, and focusing on greater presentation skills to interpret complex intelligence

1.2- Financial Services Cloud Services Manager

Occupational Standard	
(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Responsible for cloud services used in IT operations and projects. Depending on the style of organizational structure, works under direction of the IT Operations Manager. Develops a coherent policy for introducing Cloud Computing throughout the organization, and ensures a thorough implementation of any application

	relying on cloud services. Acts as primary advisor to projects and programs introducing new cloud solutions. Manages selection, procurement, and implementation processes for cloud services. Monitors and benchmarks service performance.
Position Development	Advancement to position typically follows at least 15 years of experience within a financial institution
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor degree with a major in Business Technology Management (BTM), ideally combined with a graduate certificate in Project Management
Training	Professional certifications provided by data service vendors, as well as by PMI, such as PMP, RMP, and ACP
Related Work Experience	Data service support specialist, vendor relationship specialist, and quality assurance specialist
Tasks	ITUP ©Copyright IBM Corp. 2005, 2008. All Rights Reserved.
	• Develops a coherent policy for introducing Cloud Computing throughout the organization, and ensures a thorough implementation of any application relying on cloud services. o Analyze the enterprise architecture to identify potential and inconsistencies with cloud computing. o Specification of policies adapted to the financial services industry, in particular with service availability, cybersecurity, data custody and stewardship, as well as legal issues crossing jurisdictions. o Curation of a cloud vendor library, along with regular testing and benchmarking of cloud and data services. o Innovation program to stimulate the use of more efficient and effective cloud services, based on active

development of end-user awareness and application architect expertise.

- Acts as primary advisor to projects and programs introducing new cloud solutions.
    - Responsible to IT operations managers for the successful deployment of integrated or stand-alone cloud and data services into production.
    - Ensure that all cloud and data services supplied by internal and external entities, necessary in providing and supporting business and operational services, are available for use and actively managed from creation and introduction until final disposal or destruction.
- Manages selection, procurement, and implementation processes for cloud services.
    - Deliver operational data services to IT customers, by matching resources to commitments and employing the IT infrastructure to conduct IT operations.
    - Understanding, creation, and maintenance of operational schedules.
    - Scheduling, operation and execution of the IT-based services which have been committed to customers.
- Monitors and benchmarks service performance.
    - Service Execution applies the resources made available to it through Deployment Management to the dynamic mix of workload demands.
    - Makes adjustments to resource allocations within the tolerances provided and specified in the solution design.
    - Managing production workloads from submission through delivery of results and from service start to service close.
    - Starting, stopping, and other operational resource management actions on system components, applications and other services.
    - Monitoring of system resources.
    - Detecting events and sending significant events to Event Management.

	○ Understanding and maintenance of operational status.
Tools and Technology	• IT Information Library (ITIL) applied to data service management • Vendor-related data service management systems and API • IT budgeting and Service Level Agreement (SLA) systems • Thorough knowledge of various IT runtime platforms • Latest technologies (e.g., cloud, PaaS, mobile apps, etc.), • Previous generation (e.g., BPM, BI, BRMS, etc.) • Enterprise database management systems • Legacy data integration and Service Oriented Architecture (SOA) • Test and configuration management systems • Bug reporting and ticketing systems • Integrated analysis-design-build-test cycle systems
Required Competencies	
Knowledge	**Data Management** As a result of the successful implementation of this process: • Data life cycle management policies and governance capabilities are effectively provided • Data life cycle management services are sustained in order to meet or exceed service level commitments • Legal, regulatory, and business requirements are met for data privacy, quality, and retention • The accessibility, performance, cost, and value characteristics of data are established, managed and optimized throughout the full life cycle • The integrity of data at all stages of its life cycle is ensured, including protection of business (and IT) data from accidental loss and destruction Key performance indicators include:

- Customer satisfaction with data lifecycle management
- Data SLA and OLA attainment
- Data control and compliance policy attainment
- Percent of data incidents discovered
    - By Data Management and reported through Event Management
    - By users using the Service Desk
    - By other means
- Percent of incidents that do not result in a service fault
- Time to restore data
- Percent of data backup schedule activities
    - Completed as planned and scheduled
    - Rescheduled or delayed
    - Needing revision
- The elapsed time and direct costs
    - In this process domain
    - In each process step and between steps

Service Management

As a result of the successful implementation of this process:

- Services are delivered in a reliable, robust, secure, and consistent manner
- Services are provided within service level targets
- Resources needed to operate IT services are managed effectively and efficiently
- Consumable resources used to deliver services are supplied in a timely manner
- Up-to-date service metric information is available

Key performance indicators include:

- Customer satisfaction with service levels delivered
- SLA and OLA attainment
- Accuracy of CI operational status (as represented in the CMDB)
- Percent of incidents discovered
    - By service operations and reported through Event Management
    - By users using the Service Desk
    - By other means

	• Percent of incidents that do not result in a service fault
	• Percent of Operational Schedule activities
	  • Completed as planned and scheduled
	  • Rescheduled or delayed
	  • Needing revision
	• Resource utilization
	• The elapsed time and direct costs
	  • In this process domain
	  • In each process step and between steps

Skills	A person filling the this role should have these skills: • Cross-platform experience and the expertise to identify and resolve data and service integration issues • Knowledge of system level and integration level testing • Strong quality assurance background • Excellent understanding of the continuous integration practice • Proficiency in specifying and implementing testing and production environment infrastructure • Expertise with automated testing products, including how to set up automated testing, how to script automated tests, how to create automated regression test suites, and how to troubleshoot automated testing issues • Understanding of the Release and Deployment Management process specified by the Information Technology Infrastructure Library (ITIL) process at the Foundation level • Ability to work well with others on a team
Personal Attributes	
Abilities	Position IT and financial professionals as equal partners, finding equilibrium even when a key profession may be dominant within the organization, leveraging IT as enabler of innovative financial products and services, and demonstrating leadership and initiative beyond traditional IT roles.
Work Values	Develop common values with financial professionals from all around the globe, showing respect for the

	diversity of the financial services industry in different countries, and cultural sensibility in multinational organizations and/or involving international customers, where trust is a key element of service delivery.
Work Styles	Perform tasks diligently under stress, responding positively to criticism from professions with a quantitative approach, keeping focus throughout complex financial services processes, and sharing responsibility for highly critical processes, such as handling financial transactions that may put the organization at risk at any moment.
Essential Skills Profile	
Reading text	
Document use	
Writing skills	
Numeracy	Convince financial professionals by using and/or interpreting quantitative analysis astutely, leading by example in accessing and relying on the best data and most intelligent solutions, with a keen understanding of risk and performance, while creating trust by showing respect towards diverse financial professions.
Oral Communication	Speak the language of financial professionals, with current knowledge of the distinctive strategic and operational challenges of the industry, including such complex issues as quantitative analysis, value-at-risk, service and portfolio performance, regulatory compliance, and competitiveness.
Thinking Skills	
Problem Solving	Translate the multi-facetted benefits of IT in terms of business value, linking direct and indirect impacts on process and enterprise performance in the context of a financial institution, and formulating IT value

	propositions that fit the value-at-risk decision making framework of different industry segments.
Decision Making	Contribute to IT-related decisions by linking technology, operational, management, and strategic facets, focusing on value-at-risk and performance, while proposing solutions that fit the organization's risk culture, and a concern for the business value of IT from the viewpoint of financial services customers.
Job Task Planning and Organizing	Integrate the best of generic, IT, and industry-specific project management practices and standards, ensuring IT projects remain aligned with the evolving needs of the financial institution and its industry segment, and developing a strong project learning culture for sustained performance improvement.
Significant Use of Memory	
Finding Information	Lead by example in teaching financial professionals how to leverage seamless IT-based communications, especially in organizations with a conservative culture, primarily by demonstrating the value of new technologies, while ensuring keeping organizations human-friendly and ensuring trust and reliability.
Working with Others	Engage both IT and financial professionals to share common goals, exploiting hybrid interpretation skills for addressing the complex interdependencies between technology and financial service, and distinguishing oneself by conceiving innovative solutions that surpass results from traditional approaches.
Continuous Learning	Support learning and change in IT projects throughout the organization, responding diligently to knowledge gaps in projects by staffing the best people and skills, learning how to integrate knowledge from the relevant IT and financial professions, and developing the organizational memory through successive projects.

Additional Information	
Physical Aspects	This position does not involve any exceptional physical aspects
Attitudes	This position does not involve any exceptional attitudes or endurance
Future Trends Affecting Essential Skills	Increased use of automated tools, aided by Artificial Intelligence, will require greater capabilities in using and integrating diverse information sources, and focusing on greater presentation skills to interpret complex intelligence

1.3- Financial Services Enterprise Architect

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Applies architecture principles and practices to guide organizations by maintaining the architecture of the overall IT assets and portfolio, covering business, information, process, and technology architecture layers. Reports to the IT Business Manager as custodian of enterprise architecture assets and the Project Management Office (PMO). Works closely with Systems Architects and IT Project/Program Managers to ensure a coherent solution. Performs enterprise architecture analysis, design, planning, and implementation, using a holistic approach of IT-enabled strategies. Integrates the various aspects of an organization to identify, motivate, and achieve change. Responsible for performing complex analyses of business structure and processes and to provide IT projects portfolio guidance based on the information collected. Acts as curator of organization-wide IT

	solution models, and supports IT project teams to reuse and contribute to modelling activities. Introduces evolved architecture standards allowing the organization to become more agile in IT solution design and development.
Position Development	Advancement to position typically follows at least 15 years of experience within a financial institution
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor degree with a major in Business Technology Management (BTM), or in Computer Science with extensive experience across the financial services industry, ideally combined with a graduate certificate in Project Management
Training	Professional certifications provided by platform vendors, as well as continuing education on the latest technologies (e.g., cloud, PaaS, mobile apps, etc.), and continuing update on the previous generation (e.g., BPM, BI, BRMS, etc.)
Related Work Experience	Systems analyst, systems architect, and IT project lead architect
Tasks	OpenUP © Eclipse Public License - v 1.0 • Applies architecture principles and practices to guide organizations by maintaining the architecture of the overall IT assets and portfolio, covering business, information, process, and technology architecture layers. o Leads or coordinates the technical design of systems and has overall responsibility for facilitating the major technical decisions expressed as software architecture. o Works closely with project managers in staffing and planning the project, because it is recommended that the team be organized around the architecture.

- Performs enterprise architecture analysis, design, planning, and implementation, using a holistic approach of IT-enabled strategies.
    - Identifying and documenting the architecturally significant aspects of systems as views that describe requirements, design, implementation, and deployment.
    - Ensure that the architecturally significant requirements are assigned to the proper components of the system.
    - Relies on architecture standards of the financial services industry to ensure coherent processes with risk and regulatory compliance of the product, geography, and segment.
- Responsible for performing complex analyses of business structure and processes and to provide IT projects portfolio guidance based on the information collected.
    - Teamwork with both technical and non-technical personnel to develop a common understanding of business-technology alignment, blending the perspectives of both IT and financial services disciplines.
    - Providing the rationale for architecture decisions, balancing the concerns of the various stakeholders, reducing technical risks, and ensuring that decisions are effectively communicated, validated, and followed.
- Acts as curator of organization-wide IT solution models, and supports IT project teams to reuse and contribute to modelling activities.
    - Maintains architecture standards libraries, and ensures they rely on the latest knowledge and industry standards.
    - Update architecture models and regularly test their coherence.
- Introduces evolved architecture standards allowing the organization to become more agile in IT solution design and development.
    - For smaller projects, a single person acts as both architect and project manager, but ideally these roles are performed by different people to

	ensure that the pressures of one role does not cause neglect of the other role. o For systems of scale, an architecture board is populated by the architects of each system, plus one or two chief architects. In such cases, the members of the architecture board collectively play the role of the Architect.
Tools and Technology	
	• Thorough knowledge of various IT runtime platforms • Latest technologies (e.g., cloud, PaaS, mobile apps, etc.), • Previous generation (e.g., BPM, BI, BRMS, etc.) • Model-Driven Engineering (MDE) • Enteprise Architecture Frameworks (e.g., TOGAF) • Enteprise Data Management standards (e.g., Financial Industry Business Ontology, FIBO)
Required Competencies	OpenUP © Eclipse Public License - v 1.0
Knowledge	• Assess Results • Design the Solution • Detail System-Wide Requirements • Detail Use-Case Scenarios • Develop Technical Vision • Identify and Outline Requirements • Manage Iteration • Plan Iteration • Plan Project
Skills	Architects must be well-rounded people with maturity, vision, and a depth of experience that allows for grasping issues quickly and making educated, critical judgments in the absence of complete information. Specifically, the person must possess this combination of qualifications: • **Experience in both problem and software engineering domains**, with evidence of a thorough understanding of the requirements to solve the problem and active participation in software development. If there is a team, this experience can be represented by different team members, but at least one person must be

	able to describe the overall vision for the project. • **Leadership ability** to motivate and maintain momentum for the technical effort across the various teams and to make critical decisions under pressure, plus make those decisions stick. To be effective, this role must have the authority to make technical decisions. This role cannot lead by decree, but only by the consent of the rest of the project team. To be effective, this person must earn the respect of the team members, project managers, the customer, and the user community, as well as the management team. • **Excellent communication skills** to earn trust, persuade, motivate, and mentor. The person in this role must have good communication skills, both verbally and in writing. • **Critical review skills** to make sure that the requirements to be built are clear and consistent and to make sure that the developed system adheres to the architecture. • **Goal-oriented and proactive orientation with a relentless focus on results.** This person is the technical driving force behind the project, not a visionary or dreamer. The career of a successful architect is a long series of sub-optimal decisions made in uncertainty and under pressure. Only those who can focus on doing what needs to be done will be successful. From an expertise standpoint, the Architect also needs to show both design and implementation abilities. However, from the design perspective, the effective Architect typically exhibits these traits: • Tends to be a generalist, rather than a specialist, who knows many technologies at a high level rather than a few technologies at the detailed level • Makes the broader technical decisions, thereby demonstrating broad knowledge and experience, as well as communication and leadership skills
Personal Attributes	

Abilities	Position IT and financial professionals as equal partners, finding equilibrium even when a key profession may be dominant within the organization, leveraging IT as enabler of innovative financial products and services, and demonstrating leadership and initiative beyond traditional IT roles.
Work Values	Develop common values with financial professionals from all around the globe, showing respect for the diversity of the financial services industry in different countries, and cultural sensibility in multinational organizations and/or involving international customers, where trust is a key element of service delivery.
Work Styles	Perform tasks diligently under stress, responding positively to criticism from professions with a quantitative approach, keeping focus throughout complex financial services processes, and sharing responsibility for highly critical processes, such as handling financial transactions that may put the organization at risk at any moment.
Essential Skills Profile	
Reading text	
Document use	
Writing skills	
Numeracy	Convince financial professionals by using and/or interpreting quantitative analysis astutely, leading by example in accessing and relying on the best data and most intelligent solutions, with a keen understanding of risk and performance, while creating trust by showing respect towards diverse financial professions.
Oral Communication	Speak the language of financial professionals, with current knowledge of the distinctive strategic and operational challenges of the industry, including such

	complex issues as quantitative analysis, value-at-risk, service and portfolio performance, regulatory compliance, and competitiveness.
Thinking Skills	
Problem Solving	Translate the multi-facetted benefits of IT in terms of business value, linking direct and indirect impacts on process and enterprise performance in the context of a financial institution, and formulating IT value propositions that fit the value-at-risk decision making framework of different industry segments.
Decision Making	Contribute to IT-related decisions by linking technology, operational, management, and strategic facets, focusing on value-at-risk and performance, while proposing solutions that fit the organization's risk culture, and a concern for the business value of IT from the viewpoint of financial services customers.
Job Task Planning and Organizing	Integrate the best of generic, IT, and industry-specific project management practices and standards, ensuring IT projects remain aligned with the evolving needs of the financial institution and its industry segment, and developing a strong project learning culture for sustained performance improvement.
Significant Use of Memory	
Finding Information	Lead by example in teaching financial professionals how to leverage seamless IT-based communications, especially in organizations with a conservative culture, primarily by demonstrating the value of new technologies, while ensuring keeping organizations human-friendly and ensuring trust and reliability.
Working with Others	Engage both IT and financial professionals to share common goals, exploiting hybrid interpretation skills for addressing the complex interdependencies between technology and financial service, and distinguishing

	oneself by conceiving innovative solutions that surpass results from traditional approaches.
Continuous Learning	Support learning and change in IT projects throughout the organization, responding diligently to knowledge gaps in projects by staffing the best people and skills, learning how to integrate knowledge from the relevant IT and financial professions, and developing the organizational memory through successive projects.
Additional Information	
Physical Aspects	This position does not involve any exceptional physical aspects
Attitudes	This position does not involve any exceptional attitudes or endurance
Future Trends Affecting Essential Skills	Increased use of automated tools, aided by Artificial Intelligence, will require greater capabilities in using and integrating diverse information sources, and focusing on greater presentation skills to interpret complex intelligence

1.4- Financial Services Quality Assurance Specialist

Occupational Standard	
(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Validates prior to deployment that the solution and its features conform to design specifications and requirements. Reports to IT Project/Program Managers, and works closely with other analysts and architects to ensure a coherent solution. Works closely with the IT Governance, Risk, and Compliance Manager in ensuring the organization maintains appropriate quality levels in all IT assets and services. Verifies that project interim work products exist and

	conform to standards. Works closely with business analysts on the evaluation of process performance, in order to identify areas in need of improvement. Responsible for developing testing environments and working with the configuration management team to manage the necessary quality adjustments and changes to solution elements, as defined in test cases.
Position Development	Advancement to the position typically follows 2-3 years of experience within a financial institution
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor degree with a major in Business Technology Management (BTM), or in Computer Science with extensive experience across the financial services industry
Training	Professional certifications provided by platform vendors, as well as continuing education on the latest technologies (e.g., cloud, PaaS, mobile apps, etc.), continuing update on the previous generation (e.g., BPM, BI, BRMS, etc.), and hands-on training on various IT environment and QA scenarios
Related Work Experience	Various IT project delivery roles allowing to develop a complete perspective of QA for financial services IT, such as business analyst, systems analyst, and testing specialist
Tasks	OpenUP © Eclipse Public License - v 1.0 • Validates prior to deployment that the solution and its features conform to design specifications and requirements. o Identifying the quality standards and tests that need to be performed o Identifying the most appropriate implementation approach for a given test, all consistent with requirements in the financial services industry o Implementing individual tests, according to the various runtime

	environments, and specific scenarios and conditions of financial services end-users, products, geography, and industry segment
	• Verifies that project interim work products exist and conform to standards.
	  o Setting up and running the tests
	  o Logging outcomes and verifying that the tests have been run
	  o Analyzing and guiding the recovery from execution errors
	  o Communicating test results to the team
	• Works closely with business analysts on the evaluation of process performance, in order to identify areas in need of improvement.
	  o Manages an continuous testing environment, integrated to development team servers
	  o Manage the flow of configuration changes, based on test conformity and performance
	• Responsible for developing testing environments and working with the configuration management team to manage the necessary quality adjustments and changes to solution elements, as defined in test cases.
	  o Identify key changes to system architecture and implementation that conform to quality standards, especially within the diverse contexts of the financial services industry

Tools and Technology	
	• Thorough knowledge of various IT runtime platforms • Latest technologies (e.g., cloud, PaaS, mobile apps, etc.), • Previous generation (e.g., BPM, BI, BRMS, etc.) • Model-Driven Engineering (MDE) • Test-Driven Development (TDD) • Test and configuration management systems • Bug reporting and ticketing systems • Integrated analysis-design-build-test cycle systems
Required Competencies	OpenUP © Eclipse Public License - v 1.0

Knowledge	• Assess Results • Design the Solution • Detail System-Wide Requirements • Detail Use-Case Scenarios • Identify and Outline Requirements • Implement Developer Tests • Implement Solution • Manage Iteration • Plan Iteration • Plan Project
Skills	A person filling the this role should have these skills: • Knowledge of testing approaches and techniques • Diagnostic and problem-solving skills • Knowledge of the system or application being tested (desirable) • Knowledge of networking and system architecture (desirable) Where automated testing is required, consider requiring these additional qualifications: • Training in the appropriate use of test automation tools • Experience using test automation tools • Programming skills • Debugging and diagnostic skills **Note:** Specific skill requirements vary depending on the type of testing that you are conducting. For example, the skills needed to successfully use system load-testing automation tools are different from those needed for the automation of system functional testing.
Personal Attributes	
Abilities	Position IT and financial professionals as equal partners, finding equilibrium even when a key profession may be dominant within the organization, leveraging IT as enabler of innovative financial products and services, and demonstrating leadership and initiative beyond traditional IT roles.

Work Values	Develop common values with financial professionals from all around the globe, showing respect for the diversity of the financial services industry in different countries, and cultural sensibility in multinational organizations and/or involving international customers, where trust is a key element of service delivery.
Work Styles	Perform tasks diligently under stress, responding positively to criticism from professions with a quantitative approach, keeping focus throughout complex financial services processes, and sharing responsibility for highly critical processes, such as handling financial transactions that may put the organization at risk at any moment.
Essential Skills Profile	
Reading text	
Document use	
Writing skills	
Numeracy	Convince financial professionals by using and/or interpreting quantitative analysis astutely, leading by example in accessing and relying on the best data and most intelligent solutions, with a keen understanding of risk and performance, while creating trust by showing respect towards diverse financial professions.
Oral Communication	Speak the language of financial professionals, with current knowledge of the distinctive strategic and operational challenges of the industry, including such complex issues as quantitative analysis, value-at-risk, service and portfolio performance, regulatory compliance, and competitiveness.
Thinking Skills	
Problem Solving	Translate the multi-facetted benefits of IT in terms of business value, linking direct and indirect impacts on

	process and enterprise performance in the context of a financial institution, and formulating IT value propositions that fit the value-at-risk decision making framework of different industry segments.
Decision Making	Contribute to IT-related decisions by linking technology, operational, management, and strategic facets, focusing on value-at-risk and performance, while proposing solutions that fit the organization's risk culture, and a concern for the business value of IT from the viewpoint of financial services customers.
Job Task Planning and Organizing	Integrate the best of generic, IT, and industry-specific project management practices and standards, ensuring IT projects remain aligned with the evolving needs of the financial institution and its industry segment, and developing a strong project learning culture for sustained performance improvement.
Significant Use of Memory	
Finding Information	Lead by example in teaching financial professionals how to leverage seamless IT-based communications, especially in organizations with a conservative culture, primarily by demonstrating the value of new technologies, while ensuring keeping organizations human-friendly and ensuring trust and reliability.
Working with Others	Engage both IT and financial professionals to share common goals, exploiting hybrid interpretation skills for addressing the complex interdependencies between technology and financial service, and distinguishing oneself by conceiving innovative solutions that surpass results from traditional approaches.
Continuous Learning	Support learning and change in IT projects throughout the organization, responding diligently to knowledge gaps in projects by staffing the best people and skills, learning how to integrate knowledge from the relevant

	IT and financial professions, and developing the organizational memory through successive projects.
Additional Information	
Physical Aspects	This position does not involve any exceptional physical aspects
Attitudes	This position does not involve any exceptional attitudes or endurance
Future Trends Affecting Essential Skills	Increased use of automated tools, aided by Artificial Intelligence, will require greater capabilities in using and integrating diverse information sources, and focusing on greater presentation skills to interpret complex intelligence

1.5- Financial Services Cyber Security Specialist

Occupational Standard	
(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Ensures information system protection, including access privileges, control structures, malware prevention, and crisis response. Reports to the IT Operations Manager, and works closely with the IT Governance, Risk, and Compliance Manager in ensuring the organization remains in conformity with security-related regulations. Selects and adapts the most appropriate security measures as per context, assessing current situation, evaluating trends, and anticipating requirements. Determines security violations and inefficiencies by conducting periodic audits. Upgrades systems by implementing and maintaining security controls and infrastructure. Introduces evolved security standards allowing the organization to become more effective in maintaining

	the organization's and its stakeholders' information secure.
Position Development	Advancement to the position typically follows 3-5 years of experience within a financial institution
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor degree with a major in Business Technology Management (BTM), or in Computer Science with extensive experience across the financial services industry
Training	Professional certifications provided by platform vendors, as well as continuing education on the latest technologies (e.g., cloud, PaaS, mobile apps, etc.), continuing update on the previous generation (e.g., BPM, BI, BRMS, etc.), and hands-on training on various IT environment and cybersecurity scenarios
Related Work Experience	Various IT project delivery as well as IT operations and support roles, allowing to develop a complete perspective of cybersecurity for financial services IT, such as business analyst, systems analyst, testing specialist, IT support, IT service management, and IT configuration management
Tasks	ITUP ©Copyright IBM Corp. 2005, 2008. All Rights Reserved.

	• Develop and ensure cybersecurity policies, information system protection, including access privileges, control structures, malware prevention, and crisis response.
	  o Understand the cybersecurity challenges of the financial services industry, as per each product, geography, and segment, especially taking in consideration the evolving diversity of end-user practices and service provisioning.
	  o Establish and operate security controls and protections over all IT assets and services in order to conform to overall

business security as well as IT-specific requirements.
    - Relate security risks and potential exposure estimates to the financial and transaction risks proper to the financial institution and its context.
- Selects and adapts the most appropriate security measures as per context, assessing current situation, evaluating trends, and anticipating requirements.
    - Mitigate the risk posed by malicious outsiders and insiders, and to decrease vulnerabilities in the IT services, systems and processes that would make it easier for such malicious parties to succeed.
    - Identify security threats, determine risks and vulnerabilities which affect the IT organization or that IT can affect, and recommend mitigating changes based on this analysis.
    - Perform a detailed analysis of the current and projected threats and vulnerabilities.
    - Once threats are identified, associate every threat with a risk and exposure estimation, including financial ad transaction implications.
    - Develop an enterprise Security Risk Assessment, which is provided to solution development teams, and will be included in the Security Risk Analysis, which will also include recommendations.
- Determines security violations and inefficiencies by conducting periodic audits.
    - Use the information submitted from threats identification processes and define all potential future threats, so that planning can begin to mitigate prior to the threat realization.
    - Detail the ramifications or impact on the organization when a threat is realized within the environment.
    - Triger necessary emergency measures for risk assessment and the discovery of vulnerabilities.
    - Detail structure within the IT organization that lends itself to the probability of a threat being realized.

	• Upgrades systems by implementing and maintaining security controls and infrastructure.
	  o Define security risk response measures that conform to enterprise risk management.
	  o Integrate response tactics within business continuity plans.
	• Introduces evolved security standards allowing the organization to become more effective in maintaining the organization's and its stakeholders' information secure.
	  o Maintain knowledge base for making security a common concern.
	  o Deploy cybersecurity best practices that conform to the culture of the financial services industry, in particular the various regulations and practices of each financial product, geography or jurisdiction, and industry or market segment

Tools and Technology	
	• Thorough knowledge of various IT runtime platforms • Latest technologies (e.g., cloud, PaaS, mobile apps, etc.), • Previous generation (e.g., BPM, BI, BRMS, etc.) • Security governance and access management technologies • IT runtime tracing and operations monitoring systems • Antivirus and high performance runtime scanning • Malware behavioral analysis systems • Intrusion detection and attack blockage technologies • Encryption and decryption standards and technologies • Emergency change management systems
Required Competencies	
Knowledge	• Security Risk Analysis • Security Monitoring Data • Security Violation

	• Security Management Evaluation • Security Risk Assessment • Change Request • Incident • Security Controls Analysis • Information Asset Security Classification • Security Policy • Security Procedures and Infrastructure • Security Plan • Change Implementation Communication
Skills	The specialist needs the following knowledge, skills, and abilities: • Expertise in identifying and understanding problems and opportunities • Ability to articulate the needs that are associated with the key problem to be solved or the opportunity to be realized • Ability to collaborate effectively with the extended team through collaborative working sessions, workshops, and other techniques. • Good communication skills, verbally and in writing • Knowledge of the business and technology domains or the ability to quickly absorb and understand such information
Personal Attributes	
Abilities	Position IT and financial professionals as equal partners, finding equilibrium even when a key profession may be dominant within the organization, leveraging IT as enabler of innovative financial products and services, and demonstrating leadership and initiative beyond traditional IT roles.
Work Values	Develop common values with financial professionals from all around the globe, showing respect for the diversity of the financial services industry in different countries, and cultural sensibility in multinational organizations and/or involving international customers, where trust is a key element of service delivery.

Work Styles	Perform tasks diligently under stress, responding positively to criticism from professions with a quantitative approach, keeping focus throughout complex financial services processes, and sharing responsibility for highly critical processes, such as handling financial transactions that may put the organization at risk at any moment.
Essential Skills Profile	
Reading text	
Document use	
Writing skills	
Numeracy	Convince financial professionals by using and/or interpreting quantitative analysis astutely, leading by example in accessing and relying on the best data and most intelligent solutions, with a keen understanding of risk and performance, while creating trust by showing respect towards diverse financial professions.
Oral Communication	Speak the language of financial professionals, with current knowledge of the distinctive strategic and operational challenges of the industry, including such complex issues as quantitative analysis, value-at-risk, service and portfolio performance, regulatory compliance, and competitiveness.
Thinking Skills	
Problem Solving	Translate the multi-facetted benefits of IT in terms of business value, linking direct and indirect impacts on process and enterprise performance in the context of a financial institution, and formulating IT value propositions that fit the value-at-risk decision making framework of different industry segments.
Decision Making	Contribute to IT-related decisions by linking technology, operational, management, and strategic facets, focusing on value-at-risk and performance,

	while proposing solutions that fit the organization's risk culture, and a concern for the business value of IT from the viewpoint of financial services customers.
Job Task Planning and Organizing	Integrate the best of generic, IT, and industry-specific project management practices and standards, ensuring IT projects remain aligned with the evolving needs of the financial institution and its industry segment, and developing a strong project learning culture for sustained performance improvement.
Significant Use of Memory	
Finding Information	Lead by example in teaching financial professionals how to leverage seamless IT-based communications, especially in organizations with a conservative culture, primarily by demonstrating the value of new technologies, while ensuring keeping organizations human-friendly and ensuring trust and reliability.
Working with Others	Engage both IT and financial professionals to share common goals, exploiting hybrid interpretation skills for addressing the complex interdependencies between technology and financial service, and distinguishing oneself by conceiving innovative solutions that surpass results from traditional approaches.
Continuous Learning	Support learning and change in IT projects throughout the organization, responding diligently to knowledge gaps in projects by staffing the best people and skills, learning how to integrate knowledge from the relevant IT and financial professions, and developing the organizational memory through successive projects.
Additional Information	
Physical Aspects	This position does not involve any exceptional physical aspects
Attitudes	This position does not involve any exceptional attitudes or endurance

Future Trends Affecting Essential Skills	Increased use of automated tools, aided by Artificial Intelligence, will require greater capabilities in using and integrating diverse information sources, and focusing on greater presentation skills to interpret complex intelligence

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Appendix B

BTM Digital Security NOS

2.0-Appendix B illustrates and explains Business Technology Management (BTM) Digital Security National Occupational Standards (NOS) Jobs.

This specialization permeates multiple sectors across multiple positions. Cyber security graduates are expected to have sufficient skills to develop, deploy, and maintain security systems, identify security gaps, and provide support for a variety of security services and platforms. Graduates of this specialization assume roles such as:

- Digital Security Management/Officer
- Digital Security Auditor
- Digital Security Consultant
- Digital Security Analyst

2.1 Digital Security Manager/Officer

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Security Manager/Officers lead a multidisciplinary team of IT and business professionals, who maintain security, develop and deploy systems that are secure and resilient when attacked. Manage vendors and negotiate contracts and build relationships with stakeholders.
Position Development	Advancement to Senior Security Director level positions is possible through increase in project scope and size of team and increase in business and technology domain knowledge. Increased responsibility in leadership positions and management experience.

	The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	(Education, Training, Related Work Experience)
Education	Completion of post-secondary school in any of the following areas: computer science, business administration, commerce or engineering, business technology management, legal, finance.
Training	Security Manager/Officer may require several years of on-the-job training, management experience but typically organizations require that the individual will already have the mandatory skills, knowledge, work related experience, and/or training.
Related Work Experience	Security Manager/Officers may require ten years of experience information or business technology or business administration. At least two year of security related experience.
Tasks	
Security Manager/Officers some or all of the following tasks:	• Plan, organize, direct, manage the activities related to security domain • Review and approve security policies and procedures • Work with other departments and senior management to provide security services and advice • Collaborate with staff, other departments, senior management, decision makers, and other professionals / associates (external to the organization) to share / provide information (as appropriate), problem solve, and to clarify management objectives • Consult with users, management, vendors, technicians, and other professionals to discuss and assess business technology security system requirements, specifications, costs and timelines • Review and / or implement security project plans • Identify and articulate potential projects to deliver changes and improvements to business system security

	• Produce analytics and metrics for business technology systems • Establish key performance indicators, monitor on-going performance, and improve performance against set security goals • Develop and deliver presentations • Manage contractor and subcontractor activities, develop performance specifications, and evaluate proposals to assess project feasibility and requirements • Control the budget and expenditures of the department or project • Stays informed of advancements in security, privacy, and data protection and applies this knowledge within the organization to improve security processes • Direct the hiring, training, supervision, mentoring, coaching, and performance evaluations of direct reporting staff
Tools and Technology	
	Security Software and general Computer Software and Hardware and Business Technology Solutions (e.g., websites, mobile applications, content management systems, collaborative technologies, security administration tools, databases, database user interface and query, electronic mail, word processing, spreadsheet, and presentation, desk top and server software components.
Required Competencies	(Knowledge, Skills, Personal Attributes)
Knowledge	Security Manager/Officers should have in depth knowledge of business domain, security and privacy and data protection standards and best practices, systems hardware, software, electronics, telecommunications, administration and management. English language (and other languages as applicable), legal, privacy, risk, and compliance, human resources, and project management. Technical knowledge and experience of network-related system components and system administration.

Skills	Security Manager/Officer should have the following skill sets: negotiation, persuasiveness, interpersonal skills, political acumen, analytical, reading comprehension, active listening, critical thinking, complex problem solving, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, financial, communication, and time management.
Personal Attributes	(Abilities, Work Values, Work Styles)
Abilities	The following abilities are important to the role of Security Manager/Officer: organizational awareness, political acumen, analytical, critical thinking, process and policy driven, inductive and deductive reasoning, problem sensitivity, prioritization, oral expression and comprehension, written comprehension and expression.
Work Values	Individuals who will succeed in this position: • lead by example and offer supportive management • seek and incorporate input from others; • empower employees to work independently; and • encourage employees to use their strongest abilities and promote achievement and accomplishment.
Work Styles	The following work styles are attributable to a Security Manager/Officer: leadership, integrity, analytical thinking, dependability, attention to detail, cooperation, persistence, self-control, initiative, innovation, concern for others, and adaptability / flexibility.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. For more detailed

	essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Security Manager/Officer **has not yet been created by ESDC**. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.

2.2- Digital Security Auditor

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Security Auditors plan, execute, and lead Information systems audits. They inspect and evaluate corporate systems, processes, procedures and security controls; produce reports to document audit results, and make recommendations to address security gaps.
Position Development	Advancement to Security Officer/Manager level positions is possible through increased business domain knowledge and increased responsibility in leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	(Education, Training, Related Work Experience)

Education	Completion of post-secondary school in any of the following areas: computer science, business administration, commerce or engineering, business technology management, legal, finance.
Training	Security Auditor may require several years of on-the-job training, management training and consulting experience but typically organizations require that the individual will already have the mandatory skills, knowledge, work related experience, and/or training.
Related Work Experience	Security Auditors may require seven years of experience information or business technology. Three years of experience in security related discipline.
Tasks	
Security Auditors some or all of the following tasks:	• Examine systems, policies and procedures and access controls • Interviews system administrators, business users, stakeholders, and business leaders to determine compliance with system access. • Evaluate compliance with operational procedures around privacy protection • Examine and audit security attributes for business systems and determine compliance • Document observation and draft recommendations for business management and approval • Provide audit report to business management and business system managers
Tools and Technology	
	Security Software and general Computer Software and Hardware and Business Technology Solutions (e.g., websites, mobile applications, content management systems, collaborative technologies, security administration tools, databases, database user interface and query, electronic mail, word processing, spreadsheet, and presentation, desk top and server software components.
Required Competencies	(Knowledge, Skills, Personal Attributes)

Knowledge	Security Auditors should have in depth knowledge of at least two business domains, security and privacy and data protection standards and best practices, systems hardware, software, electronics, telecommunications. English language (and other languages as applicable), legal, privacy, risk, and compliance, human resources, and project management. Technical knowledge and experience of network-related system components and system administration.
Skills	Security Auditor should have the following skill sets: interpersonal skills, political acumen, analytical, reading comprehension, active listening, critical thinking, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, communication, and time management.
Personal Attributes	(Abilities, Work Values, Work Styles)
Abilities	The following abilities are important to the role of Security Auditor: organizational awareness, political acumen, analytical, critical thinking, process and policy driven, inductive and deductive reasoning, prioritization, oral expression and comprehension, written comprehension and expression.
Work Values	Individuals who will succeed in this position: • Detailed oriented • Ability to identify issues and patterns • Ability to interact with diverse stakeholders • Ability to deal with ambiguity and complexity
Work Styles	The following work styles are attributable to a Security Auditor: analytical thinking, independent, persistent, and ability to meet deadlines.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. For more detailed

	essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Security Auditor has not yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.

2.3- Digital Security Consultant

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Security Consultants assess the business requirements and provide a plan to address the security issues. Provide security advice and recommendations around information security, privacy, compliance, risks, data protection, and business solutions security.
Position Development	Advancement to Security Auditor or Security Officer level positions is possible through increased business domain knowledge and increased responsibility in leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	(Education, Training, Related Work Experience)

Education	Completion of post-secondary school in any of the following areas: computer science, business administration, commerce or engineering, business technology management, legal.
Training	Security Consultant may require several years of on-the-job training, management training and consulting experience but typically organizations require that the individual will already have the mandatory skills, knowledge, work related experience, and/or training.
Related Work Experience	Security Consultants may require five years of experience information or business technology. Two years of experience in security related discipline.
Tasks	
Security Consultants some or all of the following tasks:	• Interviews stakeholders to determine the scope of the work. • Draft statement of work • Lead and implement security attributes for business systems • Conduct privacy assessments • Write recommendations for security related processes, procedures, and systems. • Deal with security incidents by evaluating causes and course of action • Perform root cause analysis • Conduct penetration testing and produce result reports
Tools and Technology	
	Security Software and general Computer Software and Hardware and Business Technology Solutions (e.g., websites, mobile applications, Cloud, content management systems, collaborative technologies, security administration tools, databases, database user interface and query, electronic mail, word processing, spreadsheet, and presentation, desk top and server software components.
Required Competencies	(Knowledge, Skills, Personal Attributes)

Knowledge	Security Consultants should have in depth knowledge of at least one business domain, security and privacy standards and best practices, systems hardware, software, electronics, telecommunications. English language (and other languages as applicable), legal, privacy, risk, and compliance, human resources, and project management. Technical knowledge and experience of network-related system components and system administration.
Skills	Security Consultant should have the following skill sets: interpersonal skills, analytical, reading comprehension, active listening, critical thinking, complex problem solving, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, communication, and time management.
Personal Attributes	(Abilities, Work Values, Work Styles)
Abilities	The following abilities are important to the role of Security Consultant: problem sensitivity, planning and organizational, political acumen, analytical, critical thinking, outside the box thinking, adaptability, flexibility, inductive and deductive reasoning, prioritization, oral expression and comprehension, written comprehension and expression.
Work Values	Individuals who will succeed in this position: • Collaborate with diverse stakeholders • Consensus building • Ability to deal with ambiguity and complexity
Work Styles	The following work styles are attributable to a Security Consultant: relationship building, analytical thinking, cooperation, collaboration, and adaptability / flexibility, ability to meet deadlines.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all

	other skills and enable people to evolve with their jobs and adapt to workplace change. For more detailed essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Security Consultant has not yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.

2.4 Digital Security Analyst

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Security Analysts write and document security requirements based on the domain of the business and the technology that will be used in the solution. Provide operational support for a variety of security services and platforms and write policies and business processes to administration and maintain the security integrity of the system. Provide monitoring, analysis and response for security incidents. Research, plan and execute counter-tactics to address the latest security vulnerabilities, advisories and incidents effecting enterprise solutions and systems

Position Development	Advancement to security Auditor or security Consultant level positions is possible through increased knowledge in business or technology domain and increased responsibility in leadership positions and consulting experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	(Education, Training, Related Work Experience)
Education	Completion of post-secondary school in any of the following areas: computer science, business administration, commerce or engineering, business technology management.
Training	Security Analyst may require several years of on-the-job training but typically organizations require that the individual will already have the mandatory skills, knowledge, work related experience, and/or training.
Related Work Experience	Security Analysts may require two years of experience information or business technology.
Tasks	
Security Analysts some or all of the following tasks:	• Interview the business and technology team to understand their requirements • Review business requirements • Review the technical solution • Create or recommend modifying operational procedures • Document administration requirements including authorization and authentication • Collaborate with legal and compliance to ensure the solution will meet legal, privacy, and compliance requirements.
Tools and Technology	
	Computer Software and Hardware and Business Technology Solutions (e.g., websites, mobile applications, content management systems, collaborative technologies, security administration tools, databases, database user interface and query,

	electronic mail, word processing, spreadsheet, and presentation, desk top and server software components.
Required Competencies	(Knowledge, Skills, Personal Attributes)
Knowledge	Security Analysts should have in depth knowledge of security concepts and best practices, systems hardware, software, electronics, and telecommunications. English language (and other languages as applicable), legal, privacy, risk, and compliance, and project management. Technical knowledge and experience of network-related system components and system administration.
Skills	Security Analyst should have the following skill sets: analytical, reading comprehension, active listening, critical thinking, complex problem solving, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, communication, and time management.
Personal Attributes	(Abilities, Work Values, Work Styles)
Abilities	The following abilities are important to the role of Security Analyst: analytical, critical thinking, outside the box thinking, adaptability, flexibility, inductive and deductive reasoning, prioritization, oral expression and comprehension, written comprehension and expression.
Work Values	Individuals who will succeed in this position: • Collaborate with diverse stakeholders • Consensus building • detailed oriented and thorough; • process oriented; • ability to deal with complexity
Work Styles	The following work styles are attributable to a Security Analyst: analytical thinking, dependability, attention to detail, cooperation, collaboration, and adaptability / flexibility.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs

	and adapt to workplace change. For more detailed essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Security Analyst has not yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.

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Appendix C

BTM Data Analytics NOS

3.0- Appendix C illustrates and explains Business Technology Management (BTM) Data Analytics National Occupational Standards (NOS) Jobs.

With the growth of analytics for business decision making, skills and competencies in data analytics are increasingly desired by industry. Graduates of this specialization are able to manipulate large data sets and produce information that informs businesses. BTM Data Analytics graduates assume roles such as:

- Business Analyst – Data Science and Analytics
- Data Analyst – Data Science and Analytics
- Data Science (Junior) – Data Science and Analytics
- Enterprise Data Architect – Data Science and Analytics
- Project Manager, Data Science and Analytics

3.1- Business Analyst – Data Science & Analytics

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	The Business Analyst's role is to direct the organization in implementing data science, analytics & technology-based solutions in a cost-effective way. The analysts other goal is to help determine which critical performance indicators should be tracked for a particular problem and to with the other members of the data science & analytics team to determine the requirements of a project or program and communicate these requirements clearly to all stakeholders, facilitators and partners. As such, the Business analyst performs an extensive range and variety of complex technical and/or professional work in a variety of businesses. The Business Analyst makes decisions which impact the success of assigned projects i.e. results, deadlines and budget. The analyst has significant influence over the allocation and management of resources

	appropriate to given assignments. The analyst can also be involved in a variety of analytical work, including data analysis depending on their skill or experience.
Position Development	Advancement to manager level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor's degree in a business, computing or engineering field. Follow up technical educational may also be required depending on the technologies in use at the various organizations.
Training	Business Analysts require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as a Business Analyst, Data Analysts or junior statistician. Often this experience may be augmented by specific industry experience using industry or use case specific tools (e.g. R, SAS, python, etc.).
Tasks	• Establish metadata management, data catalogues, data standards

	• Monitor the best practices followed for Master Data Management • Develop Data Governance standards, methodologies and rules • Develop standards and guidelines for master data issues such as data convergence, data integration, data synchronization, data definitions, etc. • Define data strategy, policies, controls and programs to ensure that enterprise data is accurate, secure and reliable • Select analysis approaches and methods that can be used to analyze data sets in order to answer critical business problems • Determine the structure that data must be in so that critical business and organizational questions can be answered • Use a variety of tools to analyze data and report findings from the data analysis itself with particular attention paid to activation • Engage with relevant internal parties and external vendors in best practice sharing and effective Data Management solution delivery • Ensuring compliance with data architecture and data engineering principles and standards • Selecting preferred data management technologies, analysis technologies, and visualization technologies
Tools and Technology	• Statistical analysis software • Data analytics or intelligence programs • Office productivity tools • Software development tools and dev ops tools including language specific IDE's, GIT, etc.
Required Competencies	
Knowledge	Business Analysts should have knowledge of: • Business Analysis techniques • Techniques relating to requirements definition, gathering, facilitation and management of business process • Cost/benefit analysis, revenue & cost forecasting, etc. • Modeling techniques and methods • System development methodologies particularly SDLC • Information and data analysis techniques • Workflow analysis and re-design

	• Policies and principles for the management of information • Relevant information standards and their appropriate use • Basic concepts, processes, technologies and workflow for purposes of analysis, design, development and implementation of information systems and applications. • Commonly used formats, structures and methods for recording and communicating data, as well as knowledge around how these are incorporated into system and application use. • Architectural relationships between key health information technology components and best practices in enterprise architecture frameworks/perspectives. • The selection and utilization of appropriate information technologies to meet business requirements. • Appropriate informatics, analysis, and data science standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety). • Data, information and workflow models used to create analytics & information technology solutions. • Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.). • An understanding of how people, resources and information flow through the organizations they are involved in • Best practices in quality improvement and process engineering to facilitate business & process transformation
Skills	Business Analysts should have skills in the following categories: Technical • Thorough and broad understanding of Business Analysis techniques, as well as best practice techniques relating to the definition, gathering, facilitation and management of projects, processes, and requirements • An understanding of and ability to apply cost/benefit analysis,

	• Modeling techniques and methods, information analysis techniques, data analysis techniques • Mastery of system development methodologies, particularly the life cycle of systems development (planning, design, build, test, deploy), best practices, etc. • An understanding of software development techniques as well as software, analytics, and data science configuration • Problem solving abilities • Architecture, analysis, and data science skills • Knowledge and understanding of business analysis/business process improvement • Knowledge and understanding of techniques for information and data analysis • Demonstrable knowledge and experience of large, complex data analytics or intelligence programs • Understanding of data technology and tools • Experience with applicable analytics platforms, tools and technologies • Architectural understanding of the data and big data ecosystems Contextual • Understanding of and ability to apply relevant Business process improvement methods and techniques • Thorough understanding of the relationship between own specialism and wider customer/organizational requirements.
Personal Attributes	A Business Analyst should have the following personal attributes: • Communication: the skills and the ability to interact professionally with a diverse group, including executives, managers, and subject matter experts. • Collaboration: the ability to collaborate with developers and subject matter experts in order to establish the technical vision and analyze trade-offs between usability and performance needs. • Expertise in relevant technical writing • People skills, especially the ability to the effectively perform and manage delegation of responsibilities • Communication skills

	• Leadership skills including ability to influence others, to lead business and technology programs, projects, workshops and initiatives, to inspire confidence and garner respect from business and technology stakeholders • Planning, supervision, coaching and delegation skills • Decision making skills • Negotiating skills • Research skills
Abilities	Business Analyst should have the following abilities: • Ability to work independently and under broad direction • Ability to work in a self-initiated mode while assuming overall accountability and responsibility for meeting allocated technical and/or project/supervisory objectives. • Ability to establish appropriate milestones, especially taking account of the personnel involved • Ability to explain complex concepts to lay person • Ability to collaborate with multiple skills and cross-functional expertise. • Ability to communicate the benefits of analytical approaches simply and clearly • Ability to communicate with top executives, business management, IT management, solution architects, technical architects, subject matter experts, partners and customers. • Ability to adapt vocabulary and style for each situation • Ability to present appropriately to a variety of audiences, including large audiences, top executives, business and technical leaders • Ability to present complex ideas with simple visuals. • Ability to seek and to find solutions to a wide range of business and technology problems • Ability to seek standardized solutions for problems where available • Ability to find solutions across a wide range of technologies and business domains. Often solutions have budget, time or operational constraints
Work Values	Individuals who are effective as Business Analysts are: • Able to communicate at all levels of organization

	• Able to present complex ideas with simple visuals • Able to find solutions across a wide range of technologies and business domains • Able to facilitate collaboration • Enjoy problem-solving • Highly analytical • Able to work independently
Work Styles	Business Analysts would have the following work styles: • Facilitation • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	A business analyst should have the following essential skills profile: • Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others • Continuous Learning
Additional Information	
Physical Aspects	Business Analysts work extensively in an office environment (sitting for long periods, repetitive computer and telephone use). However, Business Analysts may also be required to travel to satisfy the position function. Typically there is no

	heavy lifting, bending, or stooping required; however, this is determined by the needs of the organization.
Attitudes	Business Analysts should have very advanced interpersonal skills – be persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. Enterprise Data Architects must exhibit leadership, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Business Analysts work with diverse multicultural workforces.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities. A strong understanding of cloud computing will also serve all individuals in this position very well.

3.2- Data Analyst – Data Science & Analytics

Occupational Standard **(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)**	
Description of Position	Analysis of data from a variety of sources has long been a key activity within many organizations across a variety of industries. Despite this, today, the massive amount of data that may be available for analysis and the development of techniques permitting the successful analysis of such date have given a particular importance to this role and have led to

	new, emergent aspects. Data within an organization may come from many sources, is often incomplete, and may be structured and unstructured. Thus, the data analyst is responsible for importing, transforming, validating or modeling data with the purpose of understanding or drawing conclusions from the data in order to drive operational decision-making within the organization
Position Development	Advancement to manager level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor's degree in a business, computing or engineering field. Follow up technical educational may also be required depending on the technologies in use at the various organizations.
Training	Data Analysts require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as a Data Analysts or junior statisticians. Often this experience may be augmented by specific industry experience using industry or use case specific tools (e.g. R, SAS, python, etc.).
Tasks	• Establish metadata management, data catalos, data standards • Monitor the best practices followed for Master Data Management

	• Develop Data Governance standards, methodologies and rules • Develop standards and guidelines for master data issues such as data convergence, data integration, data synchronization, data definitions, etc. • Define data strategy, policies, controls and programs to ensure that enterprise data is accurate, secure and reliable • Select analysis approaches and methods that can be used to analyze data sets in order to answer critical business problems • Determine the structure that data must be in so that critical business and organizational questions can be answered • Use a variety of tools to analyze data and report findings from the data analysis itself with particular attention paid to activation • Engage with relevant internal parties and external vendors in best practice sharing and effective Data Management solution delivery • Ensuring compliance with data architecture and data engineering principles and standards • Selecting preferred data management technologies, analysis technologies, and visualization technologies
Tools and Technology	• Statistical analysis software • Data analytics or intelligence programs • Office productivity tools • Software development tools and dev ops tools including language specific IDE's, GIT, etc.
Required Competencies	
Knowledge	Data Analysts should have knowledge of: • Large complex data analytics or intelligence programs • Data, statistics, and big data concepts that relate to data analysis • Current and emerging data analysis & statistics technologies • Various architectures including distributed architectures • Software development methodologies relating to analysis • Architectural understanding of the data and big data ecosystem

	• Best practices in data delivery and measurement for the individual organizations that they work for or with • Policies and principles for the management of information • Relevant information standards and their appropriate use • Basic technologies and workflow for the purposes of analysis, design, development and implementation of information systems and applications. • Organizational or industry specific terminology and commonly used abbreviations and acronyms • Commonly used formats, structures and methods for recording and communicating data, as well as knowledge for how this data is incorporated for system and application use. • Architectural relationships between key information technology components and best practices in enterprise architecture frameworks/perspectives. • Appropriate informatics standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety). • Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.). • The ability to identify relevant sources of data needed to assess the quality of information & draw appropriate conclusions • Statistical & analytical tools, techniques and concepts • The ability to present data and information in a way that is effective for users and consumers of the data • Knowledge of the indicators and metrics important for the specific business that they are measuring
Skills	Data Analysts should have skills in the following categories: Technical • Demonstrable knowledge and experience of large, complex data analytics or intelligence programs • Statistical, pattern recognition skills • Understanding of data concepts • Understanding of data technology and tools • Experimental design, set-up, and modelling • Experience with applicable analytics platforms, tools and technologies

	• Architectural understanding of the data and big data ecosystems Contextual • Full understanding of the organization and of its requirements and opportunities in data/big data analytics • Experience in targeting tradecraft as well as experience in cargo screening, person screening, operational targeting • Experience managing a team and working with senior level Government clients on consulting projects • Strategic thinking
Personal Attributes	A Data Analyst should have the following personal attributes: • Communication skills • Presentation and public speaking skills • Rapport building and networking • Innovation and creativity • Leadership skills including ability to influence others, to lead business and technology programs, projects, workshops and initiatives, to inspire confidence and garner respect from business and technology stakeholders • Planning, supervision, coaching and delegation skills • Decision making skills • Negotiating skills • Research skills
Abilities	A Data Analyst should have the following abilities: • Ability to explain complex concepts to lay person • Ability to collaborate with multiple skills and cross-functional expertise. • Ability to communicate the benefits of analytical approaches simply and clearly • Ability to communicate with top executives, business management, IT management, solution architects, technical architects, subject matter experts, partners and customers. • Ability to adapt vocabulary and style for each situation

	• Ability to present appropriately to a variety of audiences, including large audiences, top executives, business and technical leaders • Ability to present complex ideas with simple visuals. • Ability to seek and to find solutions to a wide range of business and technology problems • Ability to seek standardized solutions for problems where available • Ability to find solutions across a wide range of technologies and business domains. Often solutions have budget, time or operational constraints
Work Values	Individuals who are effective as Data Analysts are: • Able to communicate at all levels of organization • Able to present complex ideas with simple visuals • Able to find solutions across a wide range of technologies and business domains • Able to facilitate collaboration • Enjoy problem-solving • Highly analytical • Able to work independently
Work Styles	Data analysts would have the following work styles: • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	A data analyst would have the following essential skills profile: • Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others

	• Continuous Learning
Additional Information	
Physical Aspects	Data Analysts work extensively in an office environment (sitting for long periods, repetitive computer and telephone use). However, Data Analysts may also be required to travel to satisfy the position function. Typically there is no heavy lifting, bending, or stooping required; however, this is determined by the needs of the organization.
Attitudes	Data Analysts should have very advanced interpersonal skills – be persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. Enterprise Data Architects must exhibit leadership, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Data Analysts work with diverse multicultural workforces.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities. A strong understanding of cloud computing will also serve all individuals in this position very well.

3.3- Data Scientist (Junior) – Data Science & Analytics

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Data Scientists are responsible for modeling complex Institute problems, discovering insights and identifying opportunities through the use of statistical, algorithmic, mining and visualization techniques. In addition to advanced analytic skills, this role is also proficient at integrating and preparing large, varied datasets, architecting specialized database and computing environments, and communicating results. In most organizations, Data Scientists work closely with clients, data stewards, project/program managers, and other IT teams to turn data into critical information and knowledge that can be used to make sound organizational decisions. Other responsibilities include providing data that is congruent and reliable. They need to be creative thinkers and propose innovative ways to look at problems by using data mining (the process of discovering new patterns from large datasets) approaches on the set of information available. They will need to validate their findings using an experimental and iterative approach. Also, Data Scientists will need to be able to present back their findings to the business or organization by exposing their assumptions and validation work in a way that can be easily understood by their business counterparts. These professionals will need a combination of business focus, strong analytical and problem solving skills and programming knowledge to be able to quickly cycle hypothesis through the discovery phase of the project. Excellent written and communications skills to report back the findings in a clear, structured manner are required.

Position Development	Advancement to manager level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor's degree in a business, computing or engineering field. Follow up technical educational may also be required depending on the technologies in use at the various organizations. Moreover, many organizations require senior Data Scientists to complete post-secondary school in any of the following areas: mathematics, statistics, economics, computer science, commerce, or engineering.
Training	Data Scientists require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as a junior data scientist. Often this experience may be augmented by specific industry experience using industry or use case specific tools (e.g. R, SAS, python, etc.). Data Scientists (junior) may also require several years of experience in data analysis, modelling, business requirement specification, qualification and assurance, systems analysis, data administration, software engineering, as well as project management and supervisory experience. Typically, data scientists require experience manipulating large datasets and using databases, as well experience with a general-purpose programming language (such as Hardtop MapReduce or other big data frameworks, or Java). Data scientists also typically

	have experience using statistical packages and have familiarity with basic principles of distributed computing and/or distributed databases.
Tasks	• Designs experiments, test hypotheses, and build models. • Conducts data analysis and designs algorithms • Applies basic statistical and predictive modeling techniques to build, maintain, and improve on multiple real-time decision systems • Leads discovery processes with key stakeholders to identify business requirements and expected outcomes. • Works with and alongside more senior data scientists and statisticians to build robust models • Models and frames business scenarios that are meaningful and which impact on critical business processes and/or decisions. • Identifies what data is available and relevant, including internal and external data sources, leveraging new data collection processes such as smart meters and geo-location information or social media. • Collaborates with subject matter experts to select the relevant sources of information for new, tough problems • Makes strategic recommendations on data collection, integration and retention requirements incorporating business requirements and knowledge of best practices. • Validates analysis using scenario modeling • Defines the validity of the information, how long the information is meaningful, and what other information it is related to. • Works with internal data stewards to ensure that the information used is in compliance with regulatory and security policies. • Qualifies where information can be stored or what information, external to the organization, may be used in support of the use case. • Develops usage and access control policies and systems in collaboration with the data steward. • Partners with the data stewards in continuous improvement processes impacting data quality in the context of the specific use case. • Recommends on-going improvements to methods and algorithms that lead to findings, including new information • Presents and depicts the rationale of their findings in easy to understand terms for relevant stakeholders

	• Educates their organization both from IT and the business perspectives on new approaches, such as testing hypotheses and statistical validation of results. • Helps the organization understand the principles and the math behind the process to drive organizational buy-in. • Provides business metrics for the overall project to show improvements (contribution to the improvement should be monitored initially and over multiple iterations). • Demonstrates clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness • Leads the design and deployment of enhancements and fixes to systems as needed.
Tools and Technology	• Statistical analysis software • Data analytics or intelligence programs • Office productivity tools • Software development tools and dev. ops tools including language specific IDE's, GIT, etc.
Required Competencies	
Knowledge	Data Scientists should have knowledge of: • Large complex data analytics or intelligence programs • Data, statistics, and big data concepts that relate to data analysis • Current and emerging data analysis & statistics technologies • Various architectures including distributed architectures • Software development methodologies relating to analysis • Architectural understanding of the data and big data ecosystem • Best practices in data delivery and measurement for the individual organizations that they work for or with • Policies and principles for the management of information • Relevant information standards and their appropriate use • Basic technologies and workflow for the purposes of analysis, design, development and implementation of information systems and applications. • Organizational or industry specific terminology and commonly used abbreviations and acronyms

	• Commonly used formats, structures and methods for recording and communicating data, as well as knowledge for how this data is incorporated for system and application use. • Architectural relationships between key information technology components and best practices in enterprise architecture frameworks/perspectives. • Appropriate informatics standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety). • Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.). • The ability to identify relevant sources of data needed to assess the quality of information & draw appropriate conclusions • Statistical & analytical tools, techniques and concepts • The ability to present data and information in a way that is effective for users and consumers of the data • Knowledge of the indicators and metrics important for the specific business that they are measuring
Skills	Data Scientists should have skills in the following categories: Technical • Demonstrable knowledge and experience of large, complex data analytics or intelligence programs • Statistical, pattern recognition skills • Understanding of data concepts • Understanding of data technology and tools • Experimental design, set-up, and modelling • Experience with applicable analytics platforms, tools and technologies • Architectural understanding of the data and big data ecosystems Contextual • Full understanding of the organization and of its requirements and opportunities in data/big data analytics • Experience in targeting tradecraft as well as experience in cargo screening, person screening, operational targeting • Experience managing a team and working with senior level Government clients on consulting projects

	• Strategic thinking
Personal Attributes	A Data Scientist should have the following personal attributes: • Communication skills • Presentation and public speaking skills • Rapport building and networking • Innovation and creativity • Leadership skills including ability to influence others, to lead business and technology programs, projects, workshops and initiatives, to inspire confidence and garner respect from business and technology stakeholders • Planning, supervision, coaching and delegation skills • Decision making skills • Negotiating skills • Research skills
Abilities	A Data Scientist should have the following abilities: • Ability to explain complex concepts to lay person • Ability to collaborate with multiple skills and cross-functional expertise. • Ability to communicate the benefits of analytical approaches simply and clearly • Ability to communicate with top executives, business management, IT management, solution architects, technical architects, subject matter experts, partners and customers. • Ability to adapt vocabulary and style for each situation • Ability to present appropriately to a variety of audiences, including large audiences, top executives, business and technical leaders • Ability to present complex ideas with simple visuals. • Ability to seek and to find solutions to a wide range of business and technology problems • Ability to seek standardized solutions for problems where available • Ability to find solutions across a wide range of technologies and business domains. Often solutions have budget, time or operational constraints
Work Values	Individuals who are effective as Data Scientists are: • Able to communicate at all levels of organization • Able to present complex ideas with simple visuals • Able to find solutions across a wide range of technologies and business domains

	• Able to facilitate collaboration • Enjoy problem-solving • Highly analytical • Able to work independently
Work Styles	Data Scientists would have the following work styles: • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	A Data Scientist would have the following essential skills profile: • Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others • Continuous Learning
Additional Information	
Physical Aspects	Data Scientists work extensively in an office environment (sitting for long periods, repetitive computer and telephone use). However, Data Scientists may also be required to travel to satisfy the position function. Typically there is no heavy lifting, bending, or stooping required; however, this is determined by the needs of the organization.
Attitudes	Data Scientists should have very advanced interpersonal skills – be persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. Enterprise Data Architects must exhibit leadership, people management skills,

	advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Data Scientists work with diverse multicultural workforces.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities. A strong understanding of cloud computing will also serve all individuals in this position very well.

3.4- Enterprise Data Architect – Data Science & Analytics

Occupational Standard	
(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Enterprise data architects apply architecture principles and practices to IT and business problems in order to guide organizations through the business, information, process, and technology changes necessary to execute their strategies. Enterprise data architecture involves enterprise analysis, design, planning, and implementation, using a holistic approach at all times, for the successful development and execution of strategy. These practices utilize the various aspects of an enterprise to identify, motivate, and achieve these changes. An Enterprise Data Architect is a person responsible for performing this complex analysis of business or technology structure and processes with the goal of drawing conclusions from the information collected so that a

	solution can be developed. They also create schematic documents used to solve problems and communicate those documents widely throughout their organizations.
Position Development	Advancement to management level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Post-secondary education is preferred, usually a Bachelor's degree in a business, computing or engineering field. Follow up technical educational may also be required depending on the technologies in use at the various organizations.
Training	Enterprise Data Architects require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as an Enterprise Data Architect. Often this experience may be augmented by specific industry experience using industry or use case specific tools (e.g. Cloud data tools).
Tasks	• Communicate the benefits of various architectural approaches or designs to both business and engineering audiences • Present solutions to a variety of audiences, including large audiences, top executives, business and technical leaders • Seek and find solutions to a wide range of business and technology problems • Seek standardized solutions for problems where available • Find solutions across a wide range of technologies and business domains

Tools and Technology	• Office productivity tools • Architecture diagram tools • Software development tools and dev. ops tools including language specific IDE's, GIT, etc.
Required Competencies	
Knowledge	Enterprise Data Architects should have knowledge of: • The organization, structure, and relationship between the various systems existing within an organization as well as the organization's overall structure and function • Architectural relationships between key information technology components and best practices in Enterprise Data Architecture frameworks/perspectives for the specific businesses that they are working in • Familiarity with technology frameworks that are relevant for their various industries • Hardware, software, application and systems engineering best practices and goals • Relevant organizational concepts, processes, technologies and workflow for purposes of analysis, design, development and implementation of a data science & analytics driven information system • Basic organizational terminology as well as commonly used abbreviations and acronyms • Commonly used formats, structures and methods for recording and communicating data within a specific organization, as well as an understanding on how these are incorporated into system and application use within the particular business • Appropriate informatics standards and enterprise models which enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety) • Project and program management planning and organizational skills • Financial modeling as it pertains to IT investment • IT governance and operations • Policies and principles for the management of analytics data and information • Data, information and workflow models that can be used to model information technology solutions • Key information technology concepts and components (e.g., networks, storage devices,

	operating systems, information retrieval, data warehousing, applications, firewalls, etc.) • The ability to identify relevant sources of data and information to assess quality of information and draw appropriate conclusions • Appropriate analytical and evaluation techniques and concepts • Knowledge on the best practices for visualizing and presentation data and information that is effective for users • Knowledge of indicators and metrics for organizational delivery & systems management
Skills	An Enterprise Data Architect should have skills in the following categories: Technical • The ability to understand the big picture within an organization and the relationship between domains and components within it • Systems thinking - the ability to see how parts interact with the whole (big picture thinking) • Comprehensive knowledge of hardware, software, application, and systems engineering • Project and program management planning and organizational skills • Knowledge of financial modeling as it pertains to IT investment • Ability to adopt a successful customer service orientation that applies to various stakeholders • Time management and prioritization skills • Systems & engineering thinking • Emotional intelligence Contextual • Understanding of the business for which the Enterprise Data Architecture is being developed (see above regarding various health care organizations) • Knowledge of IT governance and operations
Personal Attributes	An Enterprise Data Architect should have the following personal attributes: • Communication skills • Presentation and public speaking skills

	• Rapport building and networking • Innovation and creativity • Leadership skills including ability to influence others, to lead business and technology programs, projects, workshops and initiatives, to inspire confidence and garner respect from business and technology stakeholders • Planning, supervision, coaching and delegation skills • Decision making skills • Negotiating skills • Research skills
Abilities	An Enterprise Data Architect should have the following abilities: • Ability to communicate the benefits of architectural approaches simply and clearly • Ability to communicate with top executives, business management, IT management, solution architects, technical architects, subject matter experts, partners and customers. • Ability to adapt vocabulary and style for each situation • Ability to present appropriately to a variety of audiences, including large audiences, top executives, business and technical leaders • Ability to present complex ideas with simple visuals. • Ability to seek and to find solutions to a wide range of business and technology problems • Ability to seek standardized solutions for problems where available • Ability to find solutions across a wide range of technologies and business domains. Often solutions have budget, time or operational constraints.
Work Values	Individuals who are effective as Enterprise Data Architects are: • Able to communicate at all levels of organization • Able to present complex ideas with simple visuals • Able to find solutions across a wide range of technologies and business domains • Able to facilitate collaboration • Enjoy problem-solving • Highly analytical • Able to work independently

Work Styles	An Enterprise Data Architect would have the following work styles: • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	An Enterprise Data Architect would have the following essential skills profile: • Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others • Continuous Learning
Additional Information	
Physical Aspects	Enterprise Data Architects work extensively in an office environment (sitting for long periods, repetitive computer and telephone use). However, Enterprise Data Architects may also be required to travel to satisfy the position function. Typically there is no heavy lifting, bending, or stooping required; however, this is determined by the needs of the organization.
Attitudes	Enterprise Data Architects should have very advanced interpersonal skills – be persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. Enterprise Data Architects must exhibit leadership, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are

	important, as Enterprise Data Architects work with diverse multicultural workforces.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities. A strong understanding of cloud computing will also serve all individuals in this position very well.

3.5- Project Manager, Data Science & Analytics

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc**.)**	
Description of Position	The Project Manager, Data Science & Analytics manages all stages of the delivery of cdata sciene & analytics programs. The Project Manager, Data Science & Analytics is responsible for ensuring that deliverables are presented on time, on budget, on scope and to standards of the organization in terms of methodology, documentation, and quality. This occupation involves developing and executing activities related to end-to-end project management across multiple functional projects involved with a business program, including project plans and estimates, scoping and requirements, through implementation and deployment. In this role, the Project Manager, Data Science & Analytics will be responsible for coordinating the work of team members by developing work plans, facilitating communication, and determining next steps for completing a

	data science prototype. The Project Manager, Data Science & Analytics will then be responsible for facilitating the conversation with various teams, including engineering teams, and turning a prototype into a completed product to put in the hands of internal users or external clients. In general, the Project Manager, Data Science & Analytics oversees the planning, implementation, and tracking of a specific short/long-term project that has a beginning, an end and specified deliverables. He/she is the bridging gap between the production team and client and also ensures that the appropriate governance ensuring that all stakeholders are properly involved.
Position Development	Advancement to manager level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Post secondary education is preferred, usually a Bachelor's degree in a business, computing or engineering field. Project Managers often have masters degrees, such as a Masters in Business Administration (MBA). A professional designation Project Management Professional (PMP) is often considered an asset, though its value varies between businesses.
Training	Project Managers require on-the-job experience; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. To help develop their skills, Project Managers may take project management training courses and programs to learn additional tools and techniques.

Related Work Experience	Individuals may have experience in any of the techniques used in Project Management including current development methodologies such as Waterfall, Agile or Scrum.
Tasks	• Manage multiple inter-related projects • Engage with stakeholders • Create update, and track budgets, project plans, estimates, schedules and resource plans • Monitor and control project • Risk, issue and financial tracking • Manage change management processes within project • Manage day to day activities for project team • Provide status reports to steering committees and sponsors
Tools and Technology	• Standard Development Lifecycle (SDLC) • Project Management software • Issue management software (development) • Governance Frameworks • Office productivity and project management software • Software development tools and dev ops tools including language specific IDE's, GIT, etc.
Required Competencies	
Knowledge	A Project Manager, Data Science & Analytics, should have knowledge of: • Planning tasks and activities • Engaging with stakeholders • Change Management • Software development best practices (SD Lifecycle) • Business analysis processes, information and content flow • Large complex data analytics or intelligence programs • Data, statistics, and big data concepts that relate to data analysis, data engineering, and experimental design • Best practices in data delivery and measurement for the individual organizations that they work for or with • Policies and principles for the management of information • Relevant information standards and their appropriate use • Basic technologies and workflow for the purposes of analysis, design, development and implementation of information systems and applications.

	• Organizational or industry specific terminology and commonly used abbreviations and acronyms • Architectural relationships between key information technology components and best practices in enterprise architecture frameworks/perspectives. • Appropriate informatics standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety). • Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.). • The ability to present data and information in a way that is effective for users and consumers of the data • Knowledge of the indicators and metrics important for the specific business that they are measuring

Skills	A Project Manager, Data Science & Analytics, should have skills in the following categories:
	Technical
	• Thorough knowledge and demonstrable experience of Project Management disciplines including
	  ○ Ability to manage multiple inter-related projects and determine sensitivity and impact of events
	  ○ Project planning: estimating, scheduling, resourcing
	  ○ Project tracking and control including financial tracking
	  ○ Risk & issue management
	• Knowledge of and experience in Change Management
	• Knowledge of and experience in all aspects of systems management including SDLC, SM disciplines & governance
	• Overall knowledge of Business Analysis, including a general understanding of processes, information content/flow etc.
	• Some knowledge and experience of current development methodologies such as Waterfall, Agile or Scrum
	Contextual
	• People management skills – effective supervision and performance management

	• Knowledge and understanding of the operation of organizations, various stakeholders, and policy • Political sensitivity, ability to read issues concerns, and agendas of various stakeholders • Knowledge of and experience in managing projects, programs and teams • Some knowledge and understanding relating to financial management and budgeting • Some knowledge and understanding relating to procurement and contract negotiations - experience with stakeholder negotiations, contract terms, legal terms and conditions, etc. • Understanding of the stakeholders involved in analytics and technology, including funders, government, vendors, etc.
Personal Attributes	A Project Manager should have the following personal attributes: • Forge relationships with their organization's upper management • Engage other key stakeholders • Ensure proper level of support for the program • Deal with specific issues • Communication skills • Presentation and public speaking skills • Rapport building and networking • Innovation and creativity • Leadership skills including ability to influence others, to lead business and technology programs, projects, workshops and initiatives, to inspire confidence and garner respect from business and technology stakeholders • Planning, supervision, coaching and delegation skills • Decision making skills • Negotiating skills • Research skills
Abilities	A Project Manager, Data Science & Analytics, should have the following abilities • Leadership skills, including ability: o To keep the project team members engaged o To keep all other stakeholders engaged o To motivate and inspire project team o To display personal courage and conviction – for example to stop a project if the

	conditions for success are not present or if business conditions change.
	• Effective communication skills, both oral and written, including so as to have the ability
	  ○ To communicate the overall vision to senior management and an audience of stakeholders,
	  ○ To frame their messaging, so as to emphasize issues and contingency plans clearly
	  ○ To communicate relevant project information to internal and external stakeholders.
	• Ability to identify opportunities for improvement and makes constructive suggestions for positive change
	• Ability to explain complex concepts to lay persons
	• Ability to collaborate with multiple skills and cross-functional expertise.
	• Ability to communicate with top executives, business management, IT management, solution architects, technical architects, subject matter experts, partners and customers.
	• Ability to adapt vocabulary and style for each situation
	• Ability to present appropriately to a variety of audiences, including large audiences, top executives, business and technical leaders

Work Values	Individuals who are effective as Project Managers are: • Strong communicators • Thrive working in a collaborative team environment • Enjoy problem-solving • Can lead teams that are often multi-disciplinary • Able to communicate at all levels of organization • Able to present complex ideas with simple visuals • Able to find solutions across a wide range of technologies and business domains • Able to facilitate collaboration • Enjoy problem-solving • Highly analytical • Able to work independently
Work Styles	Project Managers should have the following work styles: • Detail oriented • Cooperative • Stress tolerant • Initiative • Independent

	• Integrity • Multi-tasking • Organised
Essential Skills Profile	A Project Manager would have the following essential skills profile: • Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others • Continuous Learning
Additional Information	
Physical Aspects	Project Managers work extensively in an office environment (sitting for long periods, repetitive computer and telephone use). However, Project Managers may also be required to travel to satisfy the position function. Typically there is no heavy lifting, bending, or stooping required; however, this is determined by the needs of the organization.
Attitudes	Project Managers should have very advanced interpersonal skills – be persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. Project Managers must exhibit leadership, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Project Managers work with diverse multicultural workforces.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing

	globalization. Furthermore, familiarity with opportunities and benefits associated with “green IT” (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities. A strong understanding of cloud computing will also serve all individuals in this position very well.

ITAC Talent
Closing Page

Appendix D

BTM Entrepreneurship NOS

4.0- Appendix D illustrates and explains Business Technology Management (BTM) Entrepreneurship National Occupational Standards (NOS) Jobs.

This specialization is targeted to persons interested in intrapreneurship roles in existing industries and large corporations without restricting access to small business and start-up entrepreneurs. These people assume the responsibility of transforming existing business models, creating new and innovative ideas and models, developing and resourcing them. BTM Entrepreneurship and Innovation graduates are expected to perform responsibilities for roles such as:

- Agile Transformation Coach
- Innovation Consultant
- Process Improvement Analyst
- Product Innovation Manager
- Product Innovation Specialist
- Strategic Innovation Manager

4.1 Agile Transformation Coach

Occupational Standard

(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)

Position	Agile Transformation Coach
Description of Position	The Agile Transformation Coach's main role is to lead/initiate the adoption and execution of the Agile project management framework across the organization, focusing mainly on SCRUM and KanBan. In order for successful adoptions, the Agile Transformation Coach also have to use innovative ways to transform the organization's current waterfall project management methods/frameworks/guidelines into agile or hybrid methods while making sure all project managers, sponsors, and other stakeholders' concerns are addressed and satisfied.
Position Development	Advancement to executive management level positions is possible through progressively responsible leadership positions and

	management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Completion of post-secondary school in any of the following areas: business administration, computer science, commerce or engineering. Additional industry training will be required for this position. Also, some positions may require industry certifications in Agile Project Management as well.
Training	The Agile Transformation Coach may require on-the-job training and some project management training, but typically organizations require that the individual will already have the mandatory skills, knowledge, work- related experience, and/or training. Agile Project Management certifications such as **Agile Certified Practitioner (ACP)** from PMI (https://www.pmi.org/certification/agile-management-acp.aspx) may be preferred by certain roles. **Certified Scrum Master (CSM)** from Scrum Alliance (https://www.scrumalliance.org/certifications/practitioners/certified-scrummaster-csm) may be preferred by certain roles.
Related Work Experience	The Agile Transformation Coach may require several years of experience in Agile project management, Waterfall project management, Process Improvement, conducting training sessions, focus groups and leading agile projects. Additionally, the agile coach also requires experience with training and dealing with stakeholders and management, including designing and creating training sessions, facilitating training sessions, having experience

communicating with senior management and such.

Tasks

- Coach project teams and departmental teams on lean and agile methods/practices
- Consult the business and stakeholders to remove barriers and change processes to facilitate the delivery of more agile, innovative solutions
- Present to executives on innovation across projects by illustrating how adoption of agile is helping to achieve greater results
- Coaching product owners/business sponsors, partners and stakeholders adopt and enact scrum in their lines of business
- Analyze and compare adoption of agile practices across projects – for example, effectiveness of stand-ups, sprint planning and retrospective meetings
- Facilitate collaborative workshops for all initiatives on roadmap planning, scoping, and estimations
- Persuade and influence adoption of agile practices working with the executive team
- Communicate effectively across diverse audiences, departments and levels acting as an advocate of the Agile methodology
- Build a collaborative, trusting, and safe environment throughout the Agile organizational structure, where open communication helps surface issues for faster resolution, problems, retrospectives, creativity are shared openly

Tools and Technology

Tools and technology for the Agile Transformation Coach includes:

- Strong proficiency in Microsoft Office Suite, emphasis on Word, Excel, and PowerPoint
- Microsoft Visio, Auto-CAD and other mapping/visual tools for technical presentations, processes, and flow-charts
- Microsoft project, JIRA, KANBAN or equivalent tools for tracking projects and progress
- Office communicator tools for quick messages
- Skype for Business, WebEx, and other communication tools for hosting and facilitating virtual meetings

	• Microsoft outlook or equivalent tools for emails • Personal digital assistants or organizers to plan, manage, and schedule tasks within the day
Required Competencies	
Knowledge	An Agile Transformation Coach needs to have in-depth knowledge of the agile project management methodology. He/she must then use that knowledge to go assist other departments in transforming their project management methods to agile instead of the traditional waterfall. In doing so, the Agile Transformation Coach would have to innovate and to come up with new processes, tools, and frameworks to successfully get that organization's buy-in/adoption of the agile practice. The Agile Transformation Coach should also be very knowledgeable in the areas of business processes, waterfall project management, agile project management, swim-lane diagrams, continuous process improvement, Lean Project Management, Business Cases, System development life cycle, software development life cycle, customer experience, and technical processes and architectures (if project is more technical).
Skills	An Agile Transformation Coach should have the following skill sets: Understanding project management frameworks, project management cost and schedule, facilitating focus groups, hosting training sessions, conflict management, stakeholder analysis, handling pressure under deadline, business casing, critical-thinking, reading comprehension, active listening, complex problem solving, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, analytical, team and time management.
Personal Attributes	• Ability to analyze current projects and convert it to an agile project that can save potential costs or complete project faster

	• Ability to convey the various benefits of agile vs waterfall and explain why the specific business unit should adopt agile • Ability to host workshops and group sessions to educate project teams/units to discuss agile adoptions and benefits • Ability to use charts, graphs, and statistics to make the case that agile is better than waterfall for the specific business unit • Ability to identify key areas of improvement in a department • Ability to understand both the technical and business challenges this organization/department is facing • Ability to work with virtual teams located across different regions and cultures • Ability to think and respond quickly, adjusting project tasks and end dates in response to unplanned changes in the company • Ability and willing to seek and incorporate input from others in order to develop collaborative solutions for the various strategic initiatives.

Abilities

Work Values	Individuals who will succeed in this position: • Understanding the benefits of agile methodology in the various department/organization • Talking to decision makers and managers about adopting the agile project management method in their department • Coming up with new agile initiatives/projects to introduce to the various departments that are not yet using agile • Lead by example and offer supportive management • Seek and incorporate ideas and inputs from other teams • Encourage team to use their strongest ability and promote achievement and accomplishment
Work Styles	The following work styles are attributable to an Agile Transformation Coach: Visionary, leadership, high integrity, patient, analytical thinking, driven, dependable, attention to detail, cooperation, persistence, self-control, self-starter, take initiative, innovative, concern for others, and adaptability / flexibility.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to

	evolve with their jobs and adapt to workplace change. For more detailed essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml. The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Computer & Information Systems Manager has no yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.
Reading text	• Read text in both print and non-print media; text contained in notes, letters, memos, e-mails, manuals, specifications, books, reports, charts, tables and graphs, etc. • Must be able to read and interpret dense and complex texts, trade magazines, newsletters and periodicals, accounting and financial statements, trade terms and international standards
Document use	• Documents produced and/or used may include graphs, charts, lists, tables, schematics, drawings, schedules, labels, warning signs, information signs, etcetera, in both print and non-print media • Must be able to read simple to complex documents in which considerable inferences may be required • Must be able to read/interpret, and write/complete/produce documents • Must be able to create and / or obtain information from tables, schedules, flowcharts, schematics, etc. • Specialized knowledge of the content of the document may be required; multiple pieces of information from multiple sources are synthesized; the quality of information may be evaluated for accuracy and omissions
Writing skills	• Write on a variety of topics including documentations for new projects, writing down notes derived from the focus

	group/training session, creating and filling in process maps and flow charts, drafting emails, proposals, and business cases to be submitted along with new project conversion from waterfall to Agile
Numeracy	• Apply financial math/money math • Apply scheduling, budgeting and accounting math • Apply measurement and calculation math • Apply data analysis math • Utilize numerical estimation
Oral Communication	• Provide clear and concise direction and instructions to the various teams and departments • Professional communications with clients, staff, and colleagues using a variety of communications devices and media • Exchange information and feedback with senior management • Interview potential staff members during the recruitment process • Create presentations and present to senior management
Thinking Skills	
Problem Solving	• Ability to respond and resolve conflicts from individuals who may not yet be convinced of agile practices • Ability to persuade individuals that Agile is better for their department/projects than the traditional waterfall "old approach" • Ability to educate front-line developers, managers, and senior leaders in the ways of agile methodology. • Ability to think and respond quickly, and adjust schedules and training sessions in response to unplanned events • Ability and willingness to seek and incorporate input from others in order to develop collaborative solutions • Identify the factors causing the product to not do as well as intended using problem-solving and critical thinking methods
Decision Making	• Make decision on which department is the agile methodology better for and which are not • Make decision on if agile should be adopted in projects that have already started and are mid-flight • Make decisions in a changing work environment, with market, economic, social, and political environments taken into account. • Make decisions regarding which problems are of higher priority and which solutions are attainable in the short-term • Make decisions on which partners to work with (internal and external)
Job Task Planning and Organizing	Agile Transformation Coaches are collaborative when making decisions on various strategic projects and initiatives. Agile

	Transformation Coaches will need to make adjustments for frequent interruptions and changing priorities.
Significant Use of Memory	Agile Transformation Coaches must remember the corporate values and departmental objectives, the key stakeholders for each project, organizational priorities, privacy and security laws and regulations, and applicable product or industry related laws and regulations.
Finding Information	• Obtain information collected from speaking to front-line workers and managers • Obtain information collected from project reports and departmental and sales trends • Obtain market trend information from the marketing team
Working with Others	Agile Transformation Coaches educates project teams and often work with different departments to come up with new project frameworks. Agile Transformation Coaches provide encouragement and support to team members, and assist them in achieving their personal work objectives for the project and provide recognition when objectives have been achieved. Agile Transformation Coaches must have the capacity to build relationships both internally and externally to an organization and manage diverse multicultural workforces across countries.
Continuous Learning	Enhanced learning may be acquired as part of regular work activity, through reading or other forms of self-study, or through off-site training. Ongoing learning occurs through participation in professional organizations, seminars, formal courses, conferences, and trade shows. In addition, skills are upgraded by attending conferences liaising with industry associations, and by taking classes through educational institutions.
Additional Information	
Physical Aspects	Agile Transformation Coaches work extensively in an office environment (sitting for long periods, repetitive computer and email use). However, Agile Transformation Coaches may also be required to travel to different locations to meet with different teams if necessary. Typically, there is no heavy lifting, bending, or stooping

	required; however, this is determined by the needs of the organization and the project.
Attitudes	Agile Transformation Coaches should have very advanced interpersonal skills –persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. They must possess these soft skills in order to generate buy-in for their assistance in process improvement across departments. Agile Transformation Coaches must also exhibit leadership, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Agile Transformation Coaches work with diverse multicultural workforces and virtual teams across different countries.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities.

4.2- Innovation Consultant

Occupational Standard

(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)

Position	Innovation Consultant
Description of Position	The Innovation Consultant's main role is to provide a senior level project management and team facilitation support to strategic initiatives and improvement of projects within the company. The Innovation Consultant will be skilled in the area of process improvement and will provide key insights into developing these strategic initiatives projects so they would be completed quicker and with more certainty.
Position Development	Advancement to executive management level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Completion of post-secondary school in any of the following areas: business administration, commerce or engineering. Although not standardized, some companies require the successful candidate to also hold an MBA, a Project Management Professional (PMP), or a Lean Six-Sigma designation as well.
Training	The Strategic Innovation Manager may require on-the-job training and some project management designations such as a PMP, Lean Six-Sigma, or a MBA. Typically, organizations require that the individual will already have the mandatory skills,

	knowledge, work- related experience, and/or training. A Master of Business Administration (MBA) can be obtained through different universities or equivalent institutions. A Project management Professional (PMP) can be obtained from PMI (http://www.pmi.org/Certification/Project-Management-Professional-PMP.aspx). A Lean Six-Sigma designation can be obtained through various process improvement institutes online as well.
Related Work Experience	Innovation Consultants may require several years of experience in project management, technical project management, Process Improvement, continuous improvement, consulting, business processes, business analysis, project review, process flow charts/diagrams.
Tasks	
	• Providing consultative and technical support to managers and analysts through working on projects, mentorship and in-house education • Maintain a high level of enterprise competence, coordinate development and assignments as well as identify, capture and share expertise • Guide business and engineering teams in helping to integrate and shape new technologies and how they would fit in the existing business • Support business units in creating value and novelty with their current products and services • Deliver keynote presentations and facilitate workshops at major conferences and regional events to support the rollout of strategic initiatives • Provide daily focus and innovation towards various strategic initiatives to improve the current state of the business • Partner with Relationship Management and Sales leadership to identify strategic relationships for in-depth consulting support

	• Proactively work with operations and vendor managers to identify key relationship opportunities to target and provide in-depth coaching in order to win new partnerships • Collaborate closely with senior leadership to implement goals that align with strategy and effectively utilize the company's resources to provide innovative solutions, translating strategic goals into individual measurable goals • Preparation of detailed analysis of business processes, including client interviews, current flow validation, and development of automated flow charts detailing process steps, hand-offs and decision points • Review deliverables prepared by the project team before delivery to clients (external and internal)

Tools and Technology

	Tools and technology for the Innovation Consultant includes: • Strong proficiency in Microsoft Office Suite, emphasis on Word, Excel, and PowerPoint • Microsoft project, JIRA, KANBAN or equivalent tools for tracking projects and progress • Office communicator tools for quick messages • Skype, WebEx, and other communication tools for meetings • Microsoft outlook or equivalent email • Personal digital assistants or organizers

Required Competencies

Knowledge	An Innovation Consultant should have expert knowledge in all areas of business and operations (sales, marketing, and operations). He/she must possess the ability to oversee key strategic initiatives within the company. The Innovation Consultant also

	must have the ability to provide expertise on large, cross-departmental strategic projects and initiatives within the company, often assisting the senior program/project managers. The Innovation Consultant should also be knowledgeable in the areas of business processes, continuous process improvement, proposal writing, requirements documentation, Lean Project Management, Creating Business Cases, optimizing operations, Marketing, Project management, System development life cycle, Agile methodology, waterfall methodology, customer experience, and technical processes.
Skills	A Innovation Consultant should have the following skill sets: Conducting in-depth analysis, opportunity identification, proposal writing, facilitating workshops, delivering presentation to senior leadership, handling pressure under deadline, business casing, critical-thinking, reading comprehension, active listening, complex problem solving, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, analytical, team management and time management.
Personal Attributes	• Ability to identify key areas of improvement in a department • Ability to assist team in a company-wide initiative • Ability to analyze current processes and develop a better, more efficient process that uses less resources • Ability to understand both the technical and business challenges this organization/department is facing

	• Ability to use data derived from existing operations to come up with new initiatives/projects to offset the changes (if any) • Ability to work with virtual teams located across different regions and cultures • Ability to think and respond quickly, adjusting project tasks and end dates in response to unplanned changes in the company • Ability and willing to seek and incorporate input from others in order to develop collaborative solutions for the various strategic initiatives.

Abilities

Work Values	Individuals who will succeed in this position: • Understanding key operations and departments within a company • Converse to managers and senior leaders to understand what struggles their organizations are facing and why • Act as a subject matter experts and sit in on the various products and program meetings • Participate in governance and other project management steering committees and provide insight/value to their projects/programs • Create/Design new initiatives and projects so organization will remain competitive • Lead by example and offer supportive management • Seek ideas and inputs from other teams and offer insightful solutions • Encourage teams to utilize their strongest ability and promote achievement and accomplishment
Work Styles	The following work styles are attributable to a Innovation Consultant: Visionary, leadership, integrity, analytical thinking, dependability, attention to detail, cooperation, persistence, self control, self-starter, take initiative, innovation, concern for others, and adaptability / flexibility.

Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. For more detailed essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Innovation Consultant has no yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.
Reading text	• Read text in both print and non-print media; text contained in notes, letters, memos, e-mails, manuals, specifications, books, reports, proposals, charts, tables and graphs, etc. • Must be able to read and interpret dense and complex texts, trade magazines, newsletters and periodicals, accounting and financial statements, trade terms and international standards
Document use	• Documents produced and/or used may include graphs, charts, lists, tables, technical

	schematics, drawings, schedules, labels, warning signs, information signs, etcetera, in both print and non-print media • Must be able to read simple to complex documents in which considerable inferences may be required • Must be able to read/interpret, and write/complete/produce documents • Must be able to create and/or obtain information from tables, schedules, flowcharts, schematics, etc. • Specialized knowledge of the content of the document may be required; multiple pieces of information from multiple sources are synthesized; the quality of information may be evaluated for accuracy and omissions
Writing skills	• Write on a variety of topics including documentations for a new project/initiative, drafting emails, proposals, and business cases to be submitted along with new project/initiative
Numeracy	• Apply financial math/money math • Apply scheduling, budgeting and accounting math • Apply measurement and calculation math • Apply data analysis math • Utilize numerical estimation
Oral Communication	• Provide clear and concise direction and instructions to product team and partnering teams • Professional communications with clients, staff, and colleagues using a variety of communications devices and media • Exchange information and feedback with senior management • Interview potential staff members during the recruitment process • Create presentations and present to senior management
Thinking Skills	
Problem Solving	• Ability to respond and resolve product issues in a quick and timely fashion • Ability to think and respond quickly, and adjust schedules and operating plans in response to unplanned events • Ability and willingness to seek and incorporate input from others in order to develop collaborative solutions

	• Identify the factors causing the product to not do as well as intended using problem-solving and critical thinking methods
Decision Making	• Make decisions in a changing work environment, with market, economic, social, and political environments taken into account. • Decision are made according to problem identification and the outcome of the business case • Make decisions regarding which problems are of higher priority and which solutions are attainable in the short-term • Make decisions on which partners to work with (internal and external)
Job Task Planning and Organizing	Innovation Consultants are collaborative when making decisions on various strategic projects and initiatives. Innovation Consultants need to make adjustments for frequent interruptions and changing priorities.
Significant Use of Memory	Innovation Consultants must remember the corporate values and departmental objectives, the representatives from each department, the key stakeholders for each project, organizational priorities, privacy and security laws and regulations, and applicable product or industry related laws and regulations.
Finding Information	• Obtain information collected from speaking to directors and senior leaders • Obtain information collected from project reports and departmental operations/sales trends • Obtain market trend information from the marketing team
Working with Others	Innovation Consultants lead teams and often work with different departments to come up with new projects and initiatives. Innovation Consultant provide encouragement and support to team members, and assist them in achieving their personal work objectives for the project and provide recognition when objectives have been achieved.

	Innovation Consultants must have the capacity to build relationships both internally and externally to an organization and manage diverse multicultural workforces across countries.
Continuous Learning	Enhanced learning may be acquired as part of regular work activity, through reading or other forms of self-study, or through off-site training. Ongoing learning occurs through participation in professional organizations, seminars, formal courses, conferences, and trade shows. In addition, skills are upgraded by attending conferences liaising with industry associations, and by taking classes through educational institutions.
Additional Information	
Physical Aspects	Innovation Consultants work extensively in an office environment (sitting for long periods, repetitive computer and email use). However, Innovation Consultants may also be required to travel to different locations to meet with different teams if necessary. Innovation consultants also have the option of working from home and work site.
Attitudes	Innovation Consultants should have very advanced interpersonal skills –persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. They must possess these soft skills in order to generate buy-in for their assistance in initiatives across departments.

	Innovation Consultants must also exhibit leadership, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Innovation Consultants work with diverse multicultural workforces and virtual teams across different countries.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities.

4.3- Process Improvement Analyst

Occupational Standard

(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)

Position	Process Improvement Analyst
Description of Position	The Process Improvement Analyst's main role is assisting other teams and departments to come up with new, innovative processes/procedures to improve the company's operations. The Process Improvement Analyst's duties include planning, designing, and implementing improvements in business processes and practices while at the same time, conducting various team building/group facilitation initiatives to improve

	the communications/relationships/skills of that certain team (depending on what the initiatives are).
Position Development	Advancement to executive management level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Completion of post-secondary school in any of the following areas: business administration, computer science, commerce or engineering. Depending on work experience, some companies may also accept BA or bachelor-equivalent degree (such as communications).
Training	Depending on the position, some organizations may require the candidate to have some sort of six-sigma training (green, black, master-black belt) prior to starting the position. A Six-Sigma designation can be obtained through various process improvement institutes such as the International Association for Six Sigma Certification (www.iassc.org). Alternatively, large-scale companies also provide six sigma in-house training for employees. The Process Improvement Analyst may require on-the-job training and some process improvement training, but typically organizations require that the individual will already have the mandatory skills, knowledge, work- related experience, and/or training.

Related Work Experience	The Process Improvement Analyst may require several years of experience in project management, Process Improvement, facilitating training sessions, focus groups, internal consulting, business processes, business analysis, requirements gathering, process flow charts/diagrams, swim-lane diagrams, gap analysis, root-cause analysis.

Tasks

	• Analyze existing investigation processes and policies used by the organization and to come up with better, innovative improvements • Use of data mining, data modeling, data analysis, and problem analysis to investigate and propose innovative solutions to process improvement • Use Kaizan, Lean/Six Sigma principles to identify savings opportunities within the program, department, or organization • Assist in providing process knowledge training to different teams and business units in the organization • Provides subject matter expertise in the areas of reporting, data analysis and data models. Create cost-benefit analyses to justify new projects and programs • Review current business practices and processes, key performance indicators and customer support measures to identify and implement on-going process improvements • Build tools to predict bottle necks, capacity breaches and enable smooth operational flows for operations and projects • Identify and communicate process opportunities through process/value stream maps; experience successfully using Time and Motion Study methods • Resolve complex business issues by breaking them down into meaningful components to determine root cause and redesigning internal and external business processes • Collect data to support and perform analysis, either systemically or by observational methods

	• Facilitate discussions with key business stakeholders to generate solution ideas and provide status updates • Develop "How to" step-by-step instructions for identified work processes, including identifying the necessary resources to complete each steps

Tools and Technology

	Tools and technology for the Process Improvement Analyst includes: • Strong proficiency in Microsoft Office Suite, emphasis on Word, Excel, and PowerPoint • Microsoft Visio, Auto-CAD and other mapping/visual tools for processes and flow-charts • Microsoft project, JIRA, KANBAN or equivalent tools for tracking projects and progress • Office communicator tools for quick messages • Skype, WebEx, and other communication tools for meetings • Microsoft outlook or equivalent email • Personal digital assistants or organizers

Required Competencies

Knowledge	A Process Improvement Analyst needs to have a firm understanding of the end-to-end operating activities for the department he/she supports. He/she must then use that knowledge to map out processes and identify areas of improvements or areas of opportunities either by eliminating processes (to save costs/effort) or adding processes (to increase value to customers).

	The Process Improvement Analyst should also be knowledgeable in the areas of business processes, swim-lane diagrams, data flow diagrams, entity relationship diagrams, continuous process improvement, Lean Project Management, Business Cases, operations, marketing, project management, business cases, System development life cycle, customer experience, and technical processes.
Skills	A Process Improvement Analyst should have the following skill sets: Conducting in-depth analysis, mapping out bottle-necks, identifying customer pain points, opportunity identification, delivering presentation to senior leadership, handling pressure under deadline, business casing, critical-thinking, reading comprehension, active listening, complex problem solving, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, analytical, team management and time management.
Personal Attributes	• Ability to analyze current processes and develop a better, more innovative process that uses less resources • Ability to map out current processes and to design the improved future processes • Ability to host workshops and group sessions for teams to identify processes involved or to discuss recommended processes going forward • Ability to use charts and graphs to convey the message across to colleagues from other departments/backgrounds • Ability to identify key areas of improvement in a department • Ability to understand both the technical and business challenges this organization/department is facing • Ability to work with virtual teams located across different regions and cultures

	• Ability to think and respond quickly, adjusting project tasks and end dates in response to unplanned changes in the company • Ability and willing to seek and incorporate input from others in order to develop collaborative solutions for the various strategic initiatives.
Abilities	
Work Values	Individuals who will succeed in this position: • Understanding key operations and departments within a company • Talking to front-line workers and managers to understand what struggles their departments are facing and why • Coming up with new innovative initiatives/projects so the organization will stay and remain competitive • Lead by example and offer supportive management • Seek and incorporate ideas and inputs from other teams • Encourage team to use their strongest ability and promote achievement and accomplishment
Work Styles	The following work styles are attributable to a Process Improvement Analyst: logical, analytical thinking, integrity, attention to details, self-starter dependability, innovative, independent thinker, take initiative, cooperation, persistence, self-control, innovation, concern for others, and adaptability / flexibility.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. For more

	detailed essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Process Improvement Analyst has no yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.
Reading text	• Read text in both print and non-print media; text contained in notes, letters, memos, e-mails, manuals, specifications, books, reports, charts, tables and graphs, etc. • Must be able to read and interpret dense and complex texts, trade magazines, newsletters and periodicals, accounting and financial statements, trade terms and international standards
Document use	• Documents produced and/or used may include graphs, charts, lists, tables, schematics, drawings, schedules, labels, warning signs, information signs, etcetera, in both print and non-print media • Must be able to read simple to complex documents in which considerable inferences may be required

	• Must be able to read/interpret, and write/complete/produce documents • Must be able to create and / or obtain information from tables, schedules, flowcharts, schematics, etc. • Specialized knowledge of the content of the document may be required; multiple pieces of information from multiple sources are synthesized; the quality of information may be evaluated for accuracy and omissions
Writing skills	• Write on a variety of topics including documentations for new initiatives, creating and filling in process maps and flow charts, drafting emails, proposals, and business cases to be submitted along with new project/initiative
Numeracy	• Apply financial math/money math • Apply scheduling, budgeting and accounting math • Apply measurement and calculation math • Apply data analysis math • Utilize numerical estimation
Oral Communication	• Provide clear and concise direction and instructions to the various teams and departments • Professional communications with clients, staff, and colleagues using a variety of communications devices and media • Exchange information and feedback with senior management • Interview potential staff members during the recruitment process • Create presentations and present to senior management
Thinking Skills	
Problem Solving	• Ability to respond and resolve process/quality issues in a quick and timely fashion • Ability to think outside the box, creating new, innovative proceses and methods to reduce expenses or to increase revenue • Identify the factors causing the program to not do as well as intended using problem-solving and critical thinking methods • Ability to think and respond quickly, and adjust schedules and operating plans in response to unplanned events

	• Ability and willingness to seek and incorporate input from others in order to develop collaborative solutions
Decision Making	• Make decision on which process to eliminate/add/reinforce and which ones to ignore • Make decisions in a changing work environment, with market, economic, social, and political environments taken into account. • Decision are made according to problem identification and the outcome of the business case • Make decisions regarding which problems are of higher priority and which solutions are attainable in the short-term • Make decisions on which partners to work with (internal and external)
Job Task Planning and Organizing	Process Improvement Analysts are collaborative when working with other departments to identify area of opportunities/innovation. Process Improvement Analysts will need to make adjustments for frequent interruptions and changing priorities.
Significant Use of Memory	Process Improvement Analysts must remember the corporate values and departmental objectives, the key stakeholders for each project, organizational priorities, privacy and security laws and regulations, and applicable product or industry related laws and regulations.
Finding Information	• Obtain information collected from speaking to front-line workers and managers • Obtain information collected from project reports and departmental and sales trends • Obtain market trend information from the marketing team
Working with Others	Process Improvement Analysts frequently work with other teams and departments to come up with new, innovative process improvement initiatives and projects. Process Improvement Analysts provide encouragement and support to team members, and assist them in achieving their personal work objectives

	for the project and provide recognition when objectives have been achieved. Process Improvement Analysts must have the capacity to build relationships both internally and externally to an organization and manage diverse multicultural workforces across countries.
Continuous Learning	Enhanced learning may be acquired as part of regular work activity, through reading or other forms of self-study, or through off-site training. Ongoing learning occurs through participation in professional organizations, seminars, formal courses, conferences, and trade shows. In addition, skills are upgraded by attending conferences liaising with industry associations, and by taking classes through educational institutions.
Additional Information	
Physical Aspects	Process Improvement Analysts work extensively in an office environment (sitting for long periods, repetitive computer and email use). However, Process Improvement Analysts may also be required to travel to different locations to meet with different teams for projects.
Attitudes	Process Improvement Analysts should have very advanced interpersonal skills –persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. They must possess these soft skills in order to generate buy-in for their assistance in process improvement across departments.

	Process Improvement Analysts must also exhibit the ability to problem-solve, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Process Improvement Analysts work with diverse multicultural workforces and virtual teams across different countries.

4.4- Product Innovation Manager

Occupational Standard

(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)

Position	Product Innovation Manager
Description of Position	The Product Innovation Manager's main role is to work with other departments to successfully bring a new product to market or to reinvent an existing product for market. The product innovation manager would usually work in the area of new product introduction (NPI) team and would collaborate with the marketing, supply chain operations, and product engineering team to define and to refine that company's products and to successfully bring it to market.
Position Development	Advancement to executive management level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Completion of post-secondary school in any of the following areas: software development, computer science, business administration, marketing, mathematics, commerce or engineering. Exceptions also includes other science faculties as well (depending on the product and industry).
Training	Product Innovation Manager may require on-the-job training and some project management training, but typically organizations require that the individual will already have the mandatory skills, knowledge, work- related experience, and/or

	training. Professional designations such as Certified Product Manager (CPM) from AIPMM (http://www.aipmm.com/html/certification/cpm.php) may be preferred/required for certain positions.
Related Work Experience	Product innovation manager may require several years of experience in product road-mapping, project management, technical project management, create/evaluate business cases, feature management, requirements gathering, and using competitor analysis and other data available to improve existing product features and functions.

Tasks

- Build and manage a product roadmap to support organization's goals and future strategies.
- Participate in the customer discovery process, identifying new customer segments for the current/existing products
- Evaluate complex systems, design innovative solutions based on analysis, and work with engineering/production team to implement solutions
- Initiate and prioritize projects within engineering department, assist in determining the best technical implementation methods, track product development, and develop product launch plans.
- Synthesize and drive product strategy from interactions with business stakeholders, legal, marketing, PR and other cross-functional teams.
- Define product requirements and provide guidance to business analysts in writing of user stories
- Identify, define and size business case for new product opportunities
- Provide technical support to operations during new product launches by training production staff and coordinating with outside partners
- Work closely with the QA department to set standards and requirements for new product launches
- Determine new features and product vision for customer facing digital entities, including web sites and mobile apps

- Get stakeholder buy-in and manages stakeholders expectations for future projects
- Negotiates priorities, scope, funding, and schedule with necessary stakeholders to ensure successful project delivery

Tools and Technology

Tools and technology for the Product Innovation Manager includes:

- Strong proficiency in Microsoft Office Suite
- Microsoft project, JIRA, KANBAN or equivalent tools for tracking projects and progress
- Microsoft Visio or equivalent visualization tools for product road-mapping
- Office communicator tools for quick messages
- Microsoft outlook or equivalent email
- Personal digital assistants or organizers

Required Competencies

Knowledge

A Product Innovation Manager should have in-depth Knowledge in both business and technology. He/she must have a deep passion of the product he/she is in charge of and that product category's industry. He/she must have the ability to analyze complex technical and business challenges and be able to collaborate with various departments and teams to make it happen.

The Product Innovation Manager should also be knowledgeable in the areas of business, technology, software, hardware, project management, feature management, business cases, object-oriented design (for software), System development life cycle, software development life cycle, customer experience, and processes.

Skills	A Product Innovation Manager should have the following skill sets: handling pressure under deadlines, cost-benefit analysis, product road-mapping, negotiation, critical-thinking, reading comprehension, active listening, complex problem solving, leading project teams, working with other teams, deal with clients, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, analytical, team management and time management.
Personal Attributes	• Ability to understand what the customer/market is looking for in terms of features and functionalities • Ability to understand both the technical and business challenges the product is facing • Ability to use existing data collected from the product or competitor to make improvements in the product • Ability to work with virtual teams located across different regions and cultures • Ability to think and respond quickly, adjusting product features and release dates in response to unplanned changes in the market • Ability and willing to seek and incorporate input from others in order to develop collaborative solutions for the product line
Abilities	
Work Values	Individuals who will succeed in this position: • Taking initiative to understand the product market and competing products • Listen to customers and partners feedback on products to improve • Challenge the social norm by coming up with new and innovative ideas for the product • Lead by example and offer supportive management for features • Seek and incorporate ideas and inputs from other teams • Encourage team to use their strongest ability and promote achievement and accomplishment
Work Styles	The following work styles are attributable to a Product Innovation Manager: Working in teams, lead by example, active leadership, integrity, analytical thinking, dependability,

	attention to detail, cooperation, persistence, self control, self-starter, take initiative, innovation, concern for others, and adaptability / flexibility.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. For more detailed essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml. The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Product Innovation Manager has no yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.
Reading text	• Read text in both print and non-print media; text contained in notes, letters, memos, e-mails, manuals, specifications, books, reports, charts, tables and graphs, etc. • Must be able to read and interpret dense and complex texts, trade magazines, newsletters and periodicals,

	accounting and financial statements, trade terms and international standards
Document use	• Documents produced and/or used may include graphs, charts, lists, tables, schematics, drawings, schedules, labels, warning signs, information signs, etcetera, in both print and non-print media • Must be able to read simple to complex documents in which considerable inferences may be required • Must be able to read/interpret, and write/complete/produce documents • Must be able to create and / or obtain information from tables, schedules, flowcharts, schematics, etc. • Specialized knowledge of the content of the document may be required; multiple pieces of information from multiple sources are synthesized; the quality of information may be evaluated for accuracy and omissions
Writing skills	• Write on a variety of topics including feature requirements, use case scenarios, test cases, and product descriptions and value propositions • Write product reports and findings to team, senior management and other stakeholders • Write surveys and notes on feedback from customers
Numeracy	• Apply financial math/money math • Apply scheduling, budgeting and accounting math • Apply measurement and calculation math • Apply data analysis math • Utilize numerical estimation
Oral Communication	• Provide clear and concise direction and instructions to product team and partnering teams • Professional communications with clients, staff, and colleagues using a variety of communications devices and media • Exchange information and feedback with senior management • Interview potential customers and users during the feature identification/management process • Create presentations and present to senior management
Thinking Skills	
Problem Solving	• Ability to respond and resolve product issues in a quick and timely fashion • Ability to think and respond quickly, and adjust schedules and operating plans in response to unplanned events • Ability and willingness to seek and incorporate input from others in order to develop collaborative solutions

	• Identify the factors causing the product to not do as well as intended using problem-solving and critical thinking methods
Decision Making	• Make decisions in a changing work environment, with market, economic, social, and political environments taken into account. • Decision are made in line according to the product roadmap and vision • Make decisions regarding which features are necessary for the product and which aren't • Make decisions on which partners to work with (internal and external) • Allocate specific features activities to team members, and others such as third-party contractors
Job Task Planning and Organizing	Product Innovation Managers are collaborative when making decisions on product features and priorities. Product Innovation Managers need to make adjustments for frequent interruptions and changing priorities.
Significant Use of Memory	Product Innovation Managers must remember the product roadmap, the different features on the product, the product details, organizational priorities, privacy and security laws and regulations, and applicable product or industry related laws and regulations.
Finding Information	• Obtain information collected from existing products in various channels • Obtain information collected from competitor analysis from the marketing intelligence • Obtain market trend information from the marketing team
Working with Others	Product Innovation Managers lead teams and often work with different teams (e.g., product engineer, marketing, operations, finance.) to build, improve, and introduce products to the market. Product Innovation Managers provide encouragement and support to team members, and assist them in achieving their personal work objectives for the product and provide recognition when objectives have been achieved.

	Product Innovation Managers must have the capacity to build relationships both internally and externally to an organization and manage diverse multicultural workforces across countries.
Continuous Learning	Enhanced learning may be acquired as part of regular work activity, through reading or other forms of self-study, or through off-site training. Ongoing learning occurs through participation in professional organizations, seminars, formal courses, conferences, and trade shows. In addition, skills are upgraded by attending conferences liaising with industry associations, and by taking classes through educational institutions.
Additional Information	
Physical Aspects	Product Innovation Managers work extensively in an office environment (sitting for long periods, repetitive computer and email use). However, product innovation managers may also be required to travel to different locations to meet with different teams if necessary.
Attitudes	Product Innovation Managers should have very advanced interpersonal skills –persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. They must be able to have these skills to evangelize their product and to persuade cross-functional teams to work together for the end goal of a better product. Product Innovation Managers must also exhibit

	leadership, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Product Innovation Managers work with diverse multicultural workforces and virtual teams across different countries.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities.

4.5- Product Innovation Specialist

Occupational Standard

(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)

Position	Product Innovation Specialist
Description of Position	The Product Innovation Specialist's main role is to use innovative methods to identify areas of improvement in a specific product/line of products. Aside from daily operating duties such as providing product related tasks and creating instruction manuals, user guides, and conduct product training, the product innovation specialists is also continuously looking for innovative ways to improving the user experience of the product by identifying customer pain points and coming up with solutions to alleviating these pain points and thus, improving the product as a whole.
Position Development	Advancement to executive management level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Completion of post-secondary school in any of the following areas: software development, computer science, business administration, mathematics, commerce or engineering.
Training	Product Innovation Specialists may require on-the-job training and some project management training, but typically organizations require that the individual will already have the mandatory skills, knowledge, work- related experience, and/or training.

	Professional designations such as Certified Associate in Project Management (CAPM) from PMI (https://www.pmi.org/certification/certified-associate-project-management-capm.aspx) may be preferred for certain positions.
Related Work Experience	Product Innovation Specialists may require several years of experience in requirements gathering, technical support, coordinating tasks and project efforts, working in cross-functional teams, identifying customer needs and market trends, and technical writing.
Tasks	
	• Identify customer needs and market trends and monitor new developments in assigned functional area which may include research on new functional requirements and competing products • Gather product and targeted customer requirements, assist in communicating product vision, and work closely with development organization to create UI mockups, functional designs, product requirements, user stories, and acceptance criteria • Assist in supporting optimization projects and strategies for the current product or future products • Provide content to create marketing materials such as product slicks/profiles, webinars, presentations, demos, white papers, and product updates • Work with multiple team members in a project environment to complete various tasks set out by the project • Assist in development of training content for, Professional Services, Sales and Customer Success teams • Uses sound judgment to plan, prioritize and schedule efforts. Documents troubleshooting methodology, information, analyzes facts or conditions regarding the support issue, and determines next steps • Participates in conference calls, meetings, and other collaborative engagements with internal and external customers • Identifies repetitive service issues and determines if the issue is a system problem or training issue • Takes steps to resolve problems through reporting issues to QA/Development for consideration in future

	development efforts or by working with customers to close training gaps when repetitive issues are deemed to be training related

Tools and Technology

Tools and technology for the Product Innovation Manager includes:

- Strong proficiency in Microsoft Office Suite, emphasis on Word, Excel, and PowerPoint
- Microsoft Visio or equivalent visualization tools for product road-mapping
- Microsoft project, JIRA, KANBAN or equivalent tools for tracking product features and progress
- Office communicator tools for quick messages
- Skype, WebEX, or other collaboration communication tools
- Microsoft outlook or equivalent email tool
- Personal digital assistants or organizers

Required Competencies

Knowledge	A Product Innovation Specialists should have a good understanding of basic knowledge in both business and technology. From He/she must also understand every aspect of the product he/she is working on in terms of features, usage, and support. The product innovation will also have good relations with the front-line staff such as sales associates and technical support staff so he/she can understand the various customer pain points for the product and to come up with innovative solutions to alleviate those pain points. The Product Innovation Manager should also be knowledgeable in the areas of business, technology, technical writing, project management, business cases, customer

	experience, user experience, customer pain-points, and requirements gathering.
Skills	A Product Innovation Specialists should have the following skill sets: Handling pressure under deadlines, attention to details, working with SMES(subject matter experts), providing technical training, facilitating focus groups, excellent interpersonal skills, critical-thinking, reading comprehension, active listening, complex problem solving, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, analytical, team management and time management.
Personal Attributes	• Ability to provide excellent product training sessions to sales staff and customers • Ability to understand customer needs, pain-points, and come up with simple, customer-friendly solutions • Ability to build great relations with sales staffs, product support staffs, and partners of the product • Ability to understand what the customer/market is looking for in terms of features and functionalities • Ability to understand both the technical and business challenges this product is facing • Ability to work with virtual teams located across different regions and cultures • Ability to think and respond quickly, adjusting product features and release dates in response to unplanned changes in the market • Ability and willing to seek and incorporate input from others in order to develop collaborative solutions for the product line.
Abilities	
Work Values	Individuals who will succeed in this position: • Taking initiative to speak with product sales and support staffs to understand what problems customers are facing and areas of opportunities for this product • Challenge the social norm by coming up with new and innovative ways to make this product better for the customer • Lead by example and offer supportive management • Seek and incorporate ideas and inputs from other teams

	• Encourage sales and support staffs to use their strongest ability and promote achievement and accomplishment
Work Styles	The following work styles are attributable to a Product Innovation Specialists: supporter, informative , integrity, analytical thinking, dependability, attention to detail, cooperation, persistence, self control, self-starter, take initiative, innovation, concern for others, and adaptability / flexibility.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. For more detailed essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Product Innovation Specialist has no yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.
Reading text	• Read text in both print and non-print media; text contained in notes, letters, memos, e-mails, manuals,

	specifications, books, reports, charts, tables and graphs, etc. • Must be able to read and interpret dense and complex texts, trade magazines, newsletters and periodicals, accounting and financial statements, trade terms and international standards
Document use	• Documents produced and/or used may include graphs, charts, lists, tables, schematics, drawings, schedules, labels, warning signs, information signs, etcetera, in both print and non-print media • Must be able to read simple to complex documents in which considerable inferences may be required • Must be able to read/interpret, and write/complete/produce documents • Must be able to create and / or obtain information from tables, schedules, flowcharts, schematics, etc. • Specialized knowledge of the content of the document may be required; multiple pieces of information from multiple sources are synthesized; the quality of information may be evaluated for accuracy and omissions
Writing skills	• Write on a variety of topics including feature requirements, use case scenarios, test cases, training manuals, product instruction manuals, and product descriptions and value propositions • Write product reports and findings to team, senior management and other stakeholders
Numeracy	• Apply financial math/money math • Apply scheduling, budgeting and accounting math • Apply measurement and calculation math • Apply data analysis math • Utilize numerical estimation
Oral Communication	• Provide clear and concise direction and instructions to product team and partnering teams • Professional communications with clients, staff, and colleagues using a variety of communications devices and media • Exchange information and feedback with senior management • Interview potential staff members during the recruitment process • Create presentations and present to product managers and potentially senior management
Thinking Skills	
Problem Solving	• Ability to speak to product sales and support staff to identify and respond to product issues in a quick and timely fashion

	• Ability to work with product team to come up with solutions to product complains and other pain-points • Ability to think and respond quickly, and adjust schedules and operating plans in response to unplanned events • Ability and willingness to seek and incorporate input from others in order to develop collaborative product solutions • Identify the factors causing the product to not do as well as intended using problem-solving and critical thinking methods
Decision Making	• Make decisions in a changing work environment, with market, economic, social, and political environments taken into account. • Decision are made in line according to the product roadmap and product manager's vision • Make decisions regarding which customer complaints are of priority • Make decisions on which partners to work with (internal and external) • Allocate specific features activities to team members, and others such as third-party contractors
Job Task Planning and Organizing	Product Innovation Specialists are collaborative when making decisions on product features and priorities. Product Innovation Specialists need to make adjustments for frequent interruptions and changing priorities.
Significant Use of Memory	Product Innovation Specialists must remember the product description and model number (if any) and instructions on how to use the product, the different features on the product, the product details, organizational priorities, privacy and security laws and regulations, and applicable product or industry related laws and regulations.
Finding Information	• Obtain information from customer surveys, product usage reports, product sales and support staffs • Obtain information collected from existing products in various channels • Obtain information collected from competitor analysis from the marketing intelligence • Obtain market trend information from the marketing team
Working with Others	Product Innovation Specialists often work with different teams (e.g., product engineer, marketing, operations, finance.)

	to support the product as it gets launched into the market. Product Innovation Specialists provide encouragement and support to sales and support front-line staffs, and assist them in achieving their personal work objectives for the product. Product Innovation Specialists must have the capacity to build relationships both internally and externally to an organization and work with diverse multicultural workforces across countries.
Continuous Learning	Enhanced learning may be acquired as part of regular work activity, through reading or other forms of self-study, or through off-site training. Ongoing learning occurs through participation in professional organizations, seminars, formal courses, conferences, and trade shows. In addition, skills are upgraded by attending conferences liaising with industry associations, and by taking classes through educational institutions.
Additional Information	
Physical Aspects	Product Innovation Specialists work extensively in an office environment (sitting for long periods, repetitive computer and email use). However, Product Innovation Specialists may also be required to travel to different locations to meet with different product teams if necessary.
Attitudes	Product Innovation Specialists should have very advanced interpersonal skills –persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to

	detail. They must be able to have these skills to evangelize their product and to persuade cross-functional teams to work together for the end goal of a better product. Product Innovation Specialists must also exhibit leadership, people skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Product Innovation Specialists work with diverse multicultural workforces and virtual teams across different countries.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities.

4.6- Strategic Innovation Manager

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Position	Strategic Innovation Manager
Description of Position	The Strategic Innovation Manager's main role is to design, create, and launch innovative projects and initiatives (both external and internal) that will help solve an organization's problems. Strategic Innovation Managers tend to be closer to the business side rather than the technology side so they typically work on innovative initiatives within the company or work on innovative initiatives on the partners and vendors side.
Position Development	Advancement to executive management level positions is possible through progressively responsible leadership positions and management experience. The career path will be determined by the size, type, geographic scope, culture, and organizational structure of the firm offering employment.
Required Qualifications	
Education	Completion of post-secondary school in any of the following areas: business administration, computer science, commerce or engineering. Although not standardized, some companies require the successful candidate to also hold an MBA as well.
Training	A Master of Business Administration (MBA) can be obtained through different universities or equivalent institutions. The Strategic Innovation Manager may require on-the-job training and some project management or process improvement training, but typically organizations require that the individual will already have the mandatory skills, knowledge, work-related experience, and/or training.

Related Work Experience	Strategic innovation manager may require several years of experience in project management, managing cross-functional teams, operations, sales and distribution, marketing strategy, create/evaluate business cases, and designing customer solutions.
Tasks	
	• Apply a structured but flexible approach to the innovation process both internally, with partners and with clients • Identify new initiatives that would aid in supporting, improving, or expanding the current ecosystem • Understand customer's business goals and objectives and how it relates to the organization's products and platforms • Provide strategic recommendations based on customer's objectives and industry best practices • Develop and maintain a trusted advisor relationship with key client stakeholders • Liaise with internal cross-functional teams (Development, Support, Product, Sales, Marketing, Training) to ensure delivery of timely resolution to customer requests • Provide project management support for all company strategic projects and initiatives • Be the main point of contact for project escalations that may impact the organization • Stay informed of content marketing, emerging technologies and competitive offerings in the media, corporate and real-time content creation space • Be the internal voice for the customer within the company • Initiate and lead projects that represent a problem to our customer that is worth solving • Vividly communicate project vision, progress and challenges to senior management and other stakeholders • Coordinate between legal and marketing to drive the execution of strategic partnership agreements • Play an active role in presenting the result of our collaboration to clients and at industry events, including background research on new sectors, markets, and clients
Tools and Technology	
	Tools and technology for the Strategic Innovation Manager includes:

	• Strong proficiency in Microsoft Office Suite • Skype, WebEx, and other communication tools for meetings • Microsoft project, JIRA, KANBAN or equivalent tools for tracking projects and progress • Office communicator tools for quick messages • Microsoft outlook or equivalent email • Personal digital assistants or organizers
Required Competencies	
Knowledge	A Strategic Innovation Manager should have a good amount of knowledge in all areas of business and operations (marketing, finance, operations). He/she must possess the ability to lead teams to complete the initiatives and project he/she creates. The Strategic Innovation Manager also must have the ability to solve complex problems and being able to communicate with senior management to get their buy-in on new projects and initiatives. The Strategic Innovation Manager should also be knowledgeable in the areas of business, operations, sales and marketing, project management, business cases, System development life cycle, Agile methodology, waterfall methodology, customer experience, and processes.
Skills	A Strategic Innovation Manager should have the following skill sets: designing cross-departmental projects, cost-benefit analysis, business casing, negotiation, handling pressure under deadlines, critical-thinking, reading comprehension, active listening, complex problem solving, writing, coordination, speaking, judgment and decision making, social perceptiveness, service orientation, analytical, team management and time management.

Personal Attributes	• Ability to identify core problems that exist in the department/organization • Ability to lead the initiative and get all necessary buy-ins from internal executives as well as external partners and vendors • Ability to understand both the technical and business challenges this organization/department is facing • Ability to use data derived from existing operations to come up with new initiatives/projects to offset the changes (if any) • Ability to work with virtual teams located across different regions and cultures • Ability to think and respond quickly, adjusting product features and release dates in response to unplanned changes in the market • Ability and willing to seek and incorporate input from others in order to develop collaborative solutions for the product line.
Abilities	
Work Values	Individuals who will succeed in this position: • Talking with senior management and key leaders in the organization to understand the problems that exists • Coming up with new initiatives/projects so the organization will stay and remain competitive • Lead by example and offer supportive management • Seek and incorporate ideas and inputs from other teams • Encourage team to use their strongest ability and promote achievement and accomplishment
Work Styles	The following work styles are attributable to a Strategic Innovation Manager: Strategic-thinker leadership, visionary, integrity, analytical thinking, ambitious, high-level thinking, dependability, attention to detail, cooperation, persistence, self-control, self-starter, take initiative, innovation, concern for others, and adaptability / flexibility.
Essential Skills Profile	Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. For more

	detailed essential skills profiles please refer to the ESDC website: http://www.esdc.gc.ca/eng/jobs/les/index.shtml. The Employment and Social Development Canada (ESDC) Essential Skills Profiles focused on occupations requiring a secondary school diploma or less and on-the-job training. As such a formal Essential Skills Profile for the occupation of Strategic Innovation Manager has not yet been created by ESDC. The following section contains essential skills information identified in existing occupational standards and classified using the nine Essential Skills categories. Note that the content is not associated with ESDC and the Essential Skills Profiles.
Reading text	• Read text in both print and non-print media; text contained in notes, letters, memos, e-mails, manuals, specifications, books, reports, charts, tables and graphs, etc. • Must be able to read and interpret dense and complex texts, trade magazines, newsletters and periodicals, accounting and financial statements, trade terms and international standards
Document use	• Documents produced and/or used may include graphs, charts, lists, tables, schematics, drawings, schedules, labels, warning signs, information signs, etcetera, in both print and non-print media • Must be able to read simple to complex documents in which considerable inferences may be required • Must be able to read/interpret, and write/complete/produce documents • Must be able to create and / or obtain information from tables, schedules, flowcharts, schematics, etc. • Specialized knowledge of the content of the document may be required; multiple pieces of information from

	multiple sources are synthesized; the quality of information may be evaluated for accuracy and omissions
Writing skills	• Write on a variety of topics including documentations for a new project/initiative, drafting emails and the difference use case scenarios and business cases to be submitted along with new project/initiative
Numeracy	• Apply financial math/money math • Apply scheduling, budgeting and accounting math • Apply measurement and calculation math • Apply data analysis math • Utilize numerical estimation
Oral Communication	• Provide clear and concise direction and instructions to operations department, partners and vendors • Professional communications with clients, staff, and colleagues using a variety of communications devices and media • Exchange information and feedback with senior management • Interview potential staff members during the recruitment process • Create presentations and present to senior management
Thinking Skills	
Problem Solving	• Ability to respond and resolve product issues in a quick and timely fashion • Ability to think and respond quickly, and adjust schedules and operating plans in response to unplanned events • Ability and willingness to seek and incorporate input from others in order to develop collaborative solutions • Identify the factors causing the product to not do as well as intended using problem-solving and critical thinking methods
Decision Making	• Make decisions in a changing work environment, with market, economic, social, and political environments taken into account. • Decision are made according to problem identification and the outcome of the business case • Make decisions regarding which problems are of higher priority and which solutions are attainable in the short-term • Make decisions on which partners to work with (internal and external)
Job Task Planning and Organizing	Strategic Innovation Manager are collaborative when working with other departments, vendors, and partners to design innovative projects and initiatives. Strategic Innovation

	Managers need to make adjustments for frequent interruptions and changing priorities.
Significant Use of Memory	Strategic Innovation Managers must remember the Corporate values and departmental objectives, the key stakeholders for each projects, organizational priorities, privacy and security laws and regulations, and applicable product or industry related laws and regulations.
Finding Information	• Obtain information collected from existing products in various channels • Obtain information collected from competitor analysis from the marketing intelligence • Obtain market trend information from the marketing team
Working with Others	Strategic Innovation Manager lead teams and often work with different departments to come up with new projects and initiatives. Strategic Innovation Managers provide encouragement and support to team members, and assist them in achieving their personal work objectives for the project and provide recognition when objectives have been achieved. Strategic Innovation Managers must have the capacity to build relationships both internally and externally to an organization and manage diverse multicultural workforces across countries.
Continuous Learning	Enhanced learning may be acquired as part of regular work activity, through reading or other forms of self-study, or through off-site training. Ongoing learning occurs through participation in professional organizations, seminars, formal courses, conferences, and trade shows. In addition, skills are upgraded by attending conferences liaising with industry associations, and by taking classes through

	educational institutions.
Additional Information	
Physical Aspects	Strategic Innovation Managers work extensively in an office environment (sitting for long periods, repetitive computer and email use). However, Strategic innovation managers may also be required to travel to different locations to meet with different teams, vendors, and partners if necessary.
Attitudes	Strategic Innovation Managers should have very advanced interpersonal skills –persuasive, empathetic, able to handle pressure, creative, have a sense of urgency, and attention to detail. They must possess the these soft skills in order to generate buy-in for their initiatives across departments. Strategic Innovation Managers must also exhibit leadership, people management skills, advanced negotiation skills, advanced conflict resolution skills, and organizational and planning abilities. Adaptability and flexibility are important, as Strategic Innovation Managers work with diverse multicultural workforces and virtual teams across different countries.
Future Trends Affecting Essential Skills	The ability to speak more than one language, and an awareness of and sensitivity to the diversity of international cultures is considered a growing need in the face of increasing globalization. Furthermore, familiarity with opportunities and benefits associated with "green IT" (e.g. server energy efficiency, reducing overall power consumption

	from IT related activities, etc.) will be of increasing importance as facilities begin to manage their overall environmental footprint while seeking short and long term cost saving opportunities.

ITAC Talent
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Appendix E

BTM Health NOS

5.0- Appendix E illustrates and explains Business Technology Management (BTM) Health National Occupational Standards (NOS) Jobs.

The demand for BTM health-related skills and competencies continue to increase across industries, hospitals and provincial health departments. The Health Sector BTM Learning Outcomes and Competency Standards have been defined to address specific domain and technical knowledge in the health-related field. Expectations of BTM graduates in this area require knowledge and competencies of health-related policies, health data analytics, health technology, and ethics. Graduates of this specialization are expected to perform responsibilities for roles such as: Health Enterprise Architecture, Solutions Architect and Developer, Business, Data and Systems Analysis; and Solutions and Project Management.

For Health-related NOS are captured here:

- Health Enterprise Architect
- Health Information Technology Solutions Architect/Developer
- Health Business Analyst
- Health Data Analyst
- Health Enterprise Solutions Manager
- Health Project Manager
- Health Systems Architect

5.1- Health Enterprise Architect

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Enterprise architecture applies architecture principles and practices to guide organizations through the business, information, process, and technology changes necessary to execute their strategies. Enterprise architecture involves enterprise analysis, design, planning, and implementation, using a holistic approach at all times, for the successful development and execution of strategy. These practices

	utilize the various aspects of an enterprise to identify, motivate, and achieve these changes. An enterprise architect is a person responsible for performing this complex analysis of business structure and processes and to draw conclusions from the information collected.
Position Development	With experience and further skill development, senior positions can be obtained within an organization.
Required Qualifications	
Education	Post secondary education is preferred, usually a Bachelors degree in a business, computing or engineering field (i.e. business administration, business, management, accounting, marketing, computing and information science).
Training	Enterprise Architects require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as an Enterprise Architect in a health care organization.
Tasks	• Communicate the benefits of architectural approaches • Present to a variety of audiences, including large audiences, top executives, business and technical leaders • Seek and find solutions to a wide range of business and technology problems • Seek standardized solutions for problems where available • Find solutions across a wide range of technologies and business domains
Tools and Technology	• Office productivity tools • Architecture diagram tools
Required Competencies	
Knowledge	Enterprise Architects should have knowledge of: • The big picture within an organization (I.e., provincial health system, regional health system, multi-site organization, organization (whether acute, non-acute, community) and other

- Health systems in Canada and the different types of healthcare delivery models across the continuum of care and their interrelationships
- Architectural relationships between key health information technology components and best practices in enterprise architecture frameworks/perspectives
- Familiarity with technology frameworks such as the Canada Health Infoway EHRS blueprint
- Hardware, software, application and systems engineering
- Basic clinical and biomedical concepts, clinical care processes, technologies and workflow for purposes of analysis, design, development and implementation of health information systems and applications
- Basic clinical terminology and commonly used abbreviations and acronyms
- Commonly used formats, structures and methods for recording and communicating clinical data and how these are incorporated into system and application use
- Appropriate health informatics standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety)
- Project and program management planning and organizational skills
- Financial modeling as it pertains to IT investment
- IT governance and operations
- Policies and principles for the management of health information
- Relevant health information standards and their appropriate use
- Health data, information and workflow models to information technology solutions
- Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.)
- The need to balance the privacy of personal health information with improved care delivery and health system management
- Identifying and framing information queries in collaboration with stakeholders to meet their needs for analysis and interpretation of data
- Identify relevant sources of data and information to assess quality of information and draw appropriate conclusions

	• Appropriate analytical and evaluation techniques and concepts • Quality analysis by organizing and transforming data into reliable and meaningful information • Presenting data and information that is effective for users • Knowledge of indicators and metrics for healthcare delivery and systems management
Skills	An Enterprise Architect should have skills in the following categories: Technical • The ability to understand the big picture within an organization and the relationship between domains and co0mponents within it • Systems thinking - the ability to see how parts interact with the whole (big picture thinking) • Comprehensive knowledge of hardware, software, application, and systems engineering • Project and program management planning and organizational skills • Knowledge of financial modeling as it pertains to IT investment • Ability to adopt a successful customer service orientation • Time management and prioritization • Systems thinking • Emotional intelligence Contextual • Understanding of the business for which the enterprise architecture is being developed (see above regarding various health care organizations) • Knowledge of IT governance and operations
Personal Attributes	• Communication skills • Presentation and public speaking skills • Rapport building and networking • Innovation and creativity • Leadership skills including ability to influence others, to lead business and technology programs, projects, workshops and initiatives, to inspire confidence and garner respect from business and technology stakeholders • Planning, supervision, coaching and delegation skills • Decision making skills • Negotiating skills • Research skills

Abilities	An Enterprise Architect should have the following abilities: • Ability to communicate the benefits of architectural approaches simply and clearly • Ability to communicate with top executives, business management, IT management, solution architects, technical architects, subject matter experts, partners and customers. • Ability to adapt vocabulary and style for each situation • Ability to present appropriately to a variety of audiences, including large audiences, top executives, business and technical leaders • Ability to present complex ideas with simple visuals. • Ability to seek and to find solutions to a wide range of business and technology problems • Ability to seek standardized solutions for problems where available • Ability to find solutions across a wide range of technologies and business domains. Often solutions have budget, time or operational constraints. It takes a considerable amount of creativity to be a good enterprise architect
Work Values	Individuals who are effective as BTM Enterprise Architects are: • Able to communicate at all levels of organization • Able to present complex ideas with simple visuals • Able to find solutions across a wide range of technologies and business domains • Able to facilitate collaboration • Enjoy problem-solving • Highly analytical • Able to work independently
Work Styles	An Enterprise Architect would have the following work styles: • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	Reading text Document use Writing skills

	Numeracy Oral Communication Thinking Skills Problem Solving Decision Making Job Task Planning and Organizing Significant Use of Memory Finding Information Working with Others Continuous Learning

5.2- Health Information Technology Solutions Architect/Developer

Occupational Standard

(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)

Description of Position	The IT Solution Architect/Developer's role is to deliver shared application support services and IT solutions to support business critical processes. This position works closely with key business super users, business partners, and team members to define and translate business requirements into sound and scalable technology solutions that are aligned to department strategy. As such, the Solutions Developer is a key contributor in the pursuit of new business, understanding client requirements and crafting winning and deliverable technical solutions.
Position Development	With experience and further skill development, more senior positions can be obtained that involve additional complexity and responsibility.
Required Qualifications	
Education	Post secondary education is preferred, usually a Bachelors degree in a business, computing or engineering field (i.e. business administration, business, management, accounting, marketing, computing and information science).

Training	IT Solutions Architect/Developers require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience (3-5 years), and/or industry courses and programs. Individuals may seek specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as an IT Solutions Architect/Developer in a health care organization.
Tasks	• Plan, schedule and monitor work • Maintains an awareness of developing technologies and their application • Communicate fluently, both orally and in writing. • Present complex concepts and complex technical information to both technical and non-technical audiences • Facilitate collaboration and effective discourse between stakeholders who share common objectives
Tools and Technology	Programming Techniques Database technologies including data mining and database design Client side technologies Office productivity tools
Required Competencies	
Knowledge	BTM Solutions Architects/Developers should have knowledge of: • Architectural relationships between key health information technology components (e.g., the Canada Health Infoway EHRS blueprint) and best practices in enterprise architecture frameworks/perspectives. • Appropriate health informatics standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety) • Health data, information and workflow models to information technology solutions. • Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.)

	• The need to balance the privacy of personal health information with improved care delivery and health system management • Identifying and framing information queries in collaboration with stakeholders to meet their needs for analysis and interpretation of data • Identify relevant sources of data and information to assess quality of information and draw appropriate conclusions • Appropriate analytical and evaluation techniques and concepts • Quality analysis by organizing and transforming data into reliable and meaningful information • Presenting data and information that is effective for users • Knowledge of indicators and metrics for healthcare delivery and systems management • Diverse programming techniques • Diverse database technologies • Development methodologies and system design techniques • Client side technologies • Relevant legislation and procedures • Health systems in Canada and the different types of healthcare delivery models across the continuum of care and their interrelationships (e.g., hospitals, clinics, ambulatory centers and community health agencies, regional health authorities). • Policies and principles for the management of health information • Relevant health information standards and their appropriate use • Basic clinical and biomedical concepts, clinical care processes, technologies and workflow for purposes of analysis, design, development and implementation of health information systems and applications • Basic clinical terminology and commonly used abbreviations and acronyms • Commonly used formats, structures and methods for recording and communicating clinical data and how these are incorporated into system and application use
Skills	An IT Solutions Architect/Developer should have skills in the following categories: Technical • Knowledge of and ability to apply diverse programming techniques, such as SharePoint (2010/2013/O365), ASP.Net, C#, VB.Net, Visual Studio (2010/2013), Microsoft SQL server including SSRS and SSIS (2008/2012), and Power BI (representative list)

	• Knowledge of and ability to apply diverse Database technologies, including data mining, T-SQL, views, stored procedures, and database design • Knowledge of Development methodologies and of Systems design techniques • Knowledge of client side technologies such as JQuery, JSON, JavaScript, HTML 5, CSS, Ajax (representative list) • Demonstrates an analytical and systematic approach to problem solving • Rapidly absorbs new technical information and applies it effectively Contextual • Knowledge and understanding of relevant legislation and procedures • Ability to plan, schedule and monitor work to meet time and quality targets and in accordance with relevant legislation and procedures • Has a thorough understanding and appreciation of appreciation of the wider field of information systems, their use in relevant employment areas and how they relate to the business activities of the organization or client • Maintains an awareness of developing technologies and their application
Personal Attributes	• Takes some responsibility for personal development, in developing and maintaining broad IT industry knowledge and industry/market domain knowledge in area of expertise • Multitasking and task prioritization
Abilities	BTM Solutions Architect/Developer should have the following abilities • Ability to communicate fluently, both orally and in writing. • Ability to present and can present complex concepts and complex technical information to both technical and non-technical audiences, with her/his team, to peers and to clients • Ability to facilitate collaboration and effective discourse between stakeholders who share common objectives • Ability to interact professionally with a diverse group, executives, managers, and subject matter experts • The ability to balance multiple concurrent projects of varying priorities and shift focus from one project to another with minimal loss of productivity or quality

Work Values	Individuals who are effective as BTM Solutions Architects/Developers are: • Able to explain and present complex concepts • Able to facilitate collaboration • Enjoy problem-solving • Highly analytical • Able to work independently
Work Styles	BTM Architect would have the following work styles: • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	• Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others • Continuous Learning

5.3- Health Business Analyst

Occupational Standard
(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)

Description of Position	The Business Analyst's role is to direct the organization in implementing technology-based solutions in a cost-effective way. The Business Analyst is responsible for determining the requirements of a project or program, and for communicating these requirements clearly to all stakeholders, facilitators and partners. As such, the Business analyst performs an extensive range and variety of complex technical and/or professional work. Typically, the Business Analyst Influences her/his organization, customers, suppliers, partners and peers based on the contribution of her/his own specialism. The Business Analyst builds appropriate and effective business relationships. The Business Analyst makes decisions which impact the success of assigned projects i.e. results, deadlines and budget. Has significant influence over the allocation and management of resources appropriate to given assignments.
Position Development	With experience and further skill development senior positions can be obtained within an organization.
Required Qualifications	
Education	Post secondary education is preferred, usually a Bachelor's degree in a business, computing or engineering field (i.e. business administration, business, management, accounting, marketing, computing and information science).
Training	Business Analysts require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as Business Analysts in a health care organization.
Tasks	• Enhance, develop and deploy solutions • Identify problems and assess solutions • Tests solutions • Analyses user needs and determine appropriate solution

	• Supervise development efforts
Tools and Technology	Standard Development Lifecycle (SDLC) ITIL Business Analysis Framework Governance Framework Office productivity tools
Required Competencies	
Knowledge	Business Analysts should have knowledge of: • Business Analysis Techniques • Techniques relating to requirements definition, gathering, facilitation and management • Cost/benefit analysis • Modeling techniques and methods • System development methodologies particularly SDLC • Information and data analysis techniques • Workflow analysis and re-design • Health systems in Canada and the different types of healthcare delivery models across the continuum of care and their interrelationships (e.g., hospitals, clinics, ambulatory centres and community health agencies, regional health authorities). • Policies and principles for the management of health information • Relevant health information standards and their appropriate use • Basic clinical and biomedical concepts, clinical care processes, technologies and workflow for purposes of analysis, design, development and implementation of health information systems and applications. • Basic clinical terminology and commonly used abbreviations and acronyms. • Commonly used formats, structures and methods for recording and communicating clinical data and how these are incorporated into system and application use. • Architectural relationships between key health information technology components (e.g., the Canada Health Infoway EHRS blueprint) and best practices in enterprise architecture frameworks/perspectives. • The selection and utilization of appropriate information technologies to meet business requirements. • Appropriate health informatics standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety).

	• Health data, information and workflow models to information technology solutions. • Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.). • How people, resources and information flow through the health system. • Roles and relationships of health professionals along with the organizational and regulatory structure in which they work. • The need to balance the privacy of personal health information with improved care delivery and health system management. • Best practices in quality improvement and process engineering to facilitate business and clinical transformation
Skills	Business Analysts should have skills in the following categories: Technical • Thorough and broad understanding of Business Analysis techniques. • Thorough and broad understanding of techniques relating to requirements definition, gathering, facilitation and management, • Understanding of and ability to apply cost/benefit analysis • Understanding of and ability to apply modeling techniques and methods • Understanding of and ability to apply System Development methodologies • Understanding of and ability to apply relevant Information Analysis techniques • Understanding of and ability to apply relevant Data analysis techniques • Mastery of system development methodologies, particularly the life cycle of systems development (planning, design, build, test, deploy), best practices, • Understanding of development techniques, or software configuration • Problem solving abilities • Architecture skills • Knowledge and understanding of business analysis/business process improvement • Knowledge and understanding of techniques for information and data analysis • Some knowledge and understanding of IT governance ad of ITIL/SDLC processes

	Contextual • Understanding of and ability to apply relevant Business process improvement (methods and techniques) • Thorough understanding of the relationship between own specialism and wider customer/organisational requirements.
Personal Attributes	• Communication: the skills and the ability to interact professionally with a diverse group, including executives, managers, and subject matter experts. • Collaboration: the ability to collaborate with developers and subject matter experts in order to establish the technical vision and analyze trade-offs between usability and performance needs. • Expertise in relevant technical writing • People skills, especially the ability to the effectively perform and manage delegation of responsibilities
Abilities	Business Analyst should have the following abilities • Ability to work independently and under broad direction • Ability to work in a self-initiated mode while assuming overall accountability and responsibility for meeting allocated technical and/or project/supervisory objectives. • Ability to establish appropriate milestones, especially taking account of the personnel involved.
Work Values	Individuals who are effective as Business Analysts are: • S communicators • Thrive working in a collaborative team environment • Enjoy problem-solving • Good people management skills • Able to work independently
Work Styles	Business Analysts would have the following work styles: • Facilitation • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	• Reading text • Document use • Writing skills • Numeracy • Oral Communication

- Thinking Skills
- Problem Solving
- Decision Making
- Job Task Planning and Organizing
- Significant Use of Memory
- Finding Information
- Working with Others
- Continuous Learning

5.4- Health Data Analyst

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	Analysis of data from a variety of sources has long been a key activity within many parts of the BTM field. More recently the massive amount of data that may be available for analysis and the development of techniques permitting the successful analysis of such date have given a particular importance to this role and have led to new, emergent aspects. This data may come from sources both within the company and outside of the company. It may be structured and unstructured. The Data Analyst must be able to understand how to extract value from this data.
Position Development	With experience and further skill development senior positions can be obtained within an organization.
Required Qualifications	
Education	Post secondary education is preferred, usually a Bachelors degree in a business, computing or engineering field (i.e. business administration, business, management, accounting, marketing, computing and information science).
Training	Data Analysts require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.

Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as a Data Analysts in a health care organization.
Tasks	• Establishing metadata management, data catalogs, data standards • The use of best practices for Master Data Management • Developing Data Governance, standards, and taking architecture decisions • Develops standards and guidelines for master data issues such as data convergence, data standards and data integration/synchronization • Defining data strategy, policies, controls and programs to ensure that the enterprise data is accurate, secure and reliable • Engaging with relevant internal parties and external vendors in best practice sharing and effective Master Data Management solution delivery • Ensuring compliance with data architecture principles and standards • Selecting preferred data management technologies
Tools and Technology	• Statistical analysis software • Data analytics or intelligence programs • Office productivity tools
Required Competencies	
Knowledge	Data Analysts should have knowledge of: • Large complex data analytics or intelligence programs • Data and big data concepts • Bid data technology • Distributed architectures • Best practices at development cycles of an Agile methodology • Architectural understanding of the data and big data ecosystem • Health systems in Canada and the different types of healthcare delivery models across the continuum of care and their interrelationships (e.g., hospitals, clinics, ambulatory centres and community health agencies, regional health authorities). • Policies and principles for the management of health information • Relevant health information standards and their appropriate use • Basic clinical and biomedical concepts, clinical care processes, technologies and workflow for purposes of analysis, design, development and implementation of health information systems and applications.

	• Basic clinical terminology and commonly used abbreviations and acronyms. • Commonly used formats, structures and methods for recording and communicating clinical data and how these are incorporated into system and application use. • Architectural relationships between key health information technology components (e.g., the Canada Health Infoway EHRS blueprint) and best practices in enterprise architecture frameworks/perspectives. • Appropriate health informatics standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety). • Health data, information and workflow models to information technology solutions. • Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.). • The need to balance the privacy of personal health information with improved care delivery and health system management. • Identifying and framing information queries in collaboration with stakeholders to meet their needs for analysis and interpretation of data • Identify relevant sources of data and information to assess quality of information and draw appropriate conclusions • Appropriate analytical and evaluation techniques and concepts • Quality analysis by organizing and transforming data into reliable and meaningful information • Presenting data and information that is effective for users • Knowledge of indicators and metrics for healthcare delivery and systems management
Skills	Data Analysts should have skills in the following categories: Technical • Demonstrable knowledge and experience of large, complex data analytics or intelligence programs • Statistical, Pattern recognition skills • Understanding of new data and big data concepts • Understanding of data and big data technology and tools • Experimental thought process • Full understanding of Distributed Architectures is required. • Understanding of Best practises at development cycles of an Agile methodology • Experience configuring and tuning applicable software frameworks • Experience with applicable analytics platforms

	• Architectural understanding of the data and big data ecosystems Contextual • Full understanding of the organization and of its requirements and opportunities in data/big data analytics • Experience in targeting tradecraft as well as experience in cargo screening, person screening, operational targeting • Experience managing a team and working with senior level Government clients on consulting projects • Strategic thinking
Personal Attributes	• Good oral and written communication skills • Good proactivity and client-facing skills
Abilities	A Data Analyst should have the following abilities • Ability to explain complex concepts to lay person • Ability to collaborate with multiple skills and cross-functional expertise.
Work Values	Individuals who are effective as Data Analysts are: • Able to explain complex concepts • Enjoy problem-solving • Highly analytical • Able to work independently
Work Styles	Data analysts would have the following work styles: • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	• Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others • Continuous Learning

5.5- Health Enterprise Solutions Manager

Occupational Standard

(for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)

Description of Position	The IT Enterprise Solution Manager's role is to the bridge between business need and the supporting technology, building a holistic view of an organization to advise on technology-enabled business transformation and define IT strategy, requirements, solutions and roadmaps that deliver the business objectives in the most cost-effective manner. IT Enterprise Solution Manager has the responsibility to direct the implementation and improvement of Enterprise Architecture capabilities within the enterprise
Position Development	With experience and further skill development senior positions can be obtained within an organization.
Required Qualifications	
Education	Post secondary education is preferred, usually a Bachelors degree in a business, computing or engineering field (i.e. business administration, business, management, accounting, marketing, computing and information science).
Training	Enterprise Solutions Managers require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used in Enterprise Solutions Management in a health care organization. As well they may have held a strategic position within information technology in a health care setting.
Tasks	• Lead development of technology strategies • Programme portfolio planning

	• Development of transformational roadmaps • Vendor selection and procurement
Tools and Technology	Architecture Methodologies and tools (TOGAF, Zachman, COBIT, UML) Office productivity tools
Required Competencies	
Knowledge	Enterprise Solutions Managers should have knowledge of: • Architecture methodologies standards, frameworks and tools such as TOGAF, Zachman, COBIT, UML • Development methodologies • Development of technology strategies, programme portfolio planning and development of transformation roadmaps • Vendor or technology selection and procurement • Enterprise Architecture frameworks and methodologies • IT Strategic Planning • IT Program Management • Health systems in Canada and the different types of healthcare delivery models across the continuum of care and their interrelationships (e.g., hospitals, clinics, ambulatory centres and community health agencies, regional health authorities). • Policies and principles for the management of health information • Relevant health information standards and their appropriate use • Basic clinical and biomedical concepts, clinical care processes, technologies and workflow for purposes of analysis, design, development and implementation of health information systems and applications. • Basic clinical terminology and commonly used abbreviations and acronyms. • Commonly used formats, structures and methods for recording and communicating clinical data and how these are incorporated into system and application use. • Architectural relationships between key health information technology components (e.g., the Canada Health Infoway EHRS blueprint) and best practices in enterprise architecture frameworks/perspectives. • The selection and utilization of appropriate information technologies to meet business requirements. • Appropriate health informatics standards and enterprise models to enable system interoperability

	(e.g., terminology, data structure, system to system communication, privacy, security, safety). • Health data, information and workflow models to information technology solutions. • Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.). • How people, resources and information flow through the health system • Roles and relationships of health professionals along with the organizational and regulatory structure in which they work • The need to balance the privacy of personal health information with improved care delivery and health system management.
Skills	Enterprise Solutions Managers should have skills in the following categories: Technical • Knowledge and experience of Architecture methodologies, standards, frameworks and tools such as TOGAF, Zachman, COBIT, UML etc. • Knowledge and experience of Development methodologies • Ability to lead development of technology strategies, programme portfolio planning and development of transformation roadmaps • Knowledge and experience of vendor or technology selection and procurement • Understand Enterprise Architecture frameworks and methodologies • Understanding of and experience in IT Strategic Planning • Understanding of and experience in IT Program Management Contextual • Thorough knowledge of all IT components within the organization • Ability to present directional advice and communicate IT terms into business language • Understanding of the organization's business components and processes in order to reflect them in IT and business models Knowledge and understanding of the operation of the Organization

Personal Attributes	• Ability to communicate with influence and to forge relationships with their organization's upper management • Good organizational and process improvement skills to engage other key stakeholders
Abilities	Enterprise Solutions Managers should have the following abilities • Leadership abilities, especially the ability to lead the development of technology strategy and transformation roadmap for the organization. • Effective communication skills, particularly the ability to communicate the technology strategy and transformation roadmap at all levels of the organization.
Work Values	Individuals who are effective as Enterprise Solutions Architects are: • S communicators • Thrive working in a collaborative team environment • Enjoy problem-solving
Work Styles	Enterprise Solutions Architects would have the following work styles: • Visionary • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	• Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others • Continuous Learning

5.6- Health Project Manager

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	The Project Manager manages all stages of the delivery of business solutions. The Project Manager is responsible for ensuring that deliverables are presented on time, on budget, on scope and to standards of the organization in terms of methodology, documentation, and quality. This occupation involves developing and executing activities related to end-to-end project management across multiple functional projects involved with a business program, including project plans and estimates, scoping and requirements, through implementation and deployment. The Project Manager oversees the planning, implementation, and tracking of a specific short/long-term project that has a beginning, an end and specified deliverables. He/she is the bridging gap between the production team and client and also ensures that the appropriate governance ensuring that all stakeholders are properly involved.
Position Development	With experience and further skill development, positions with additional responsibility and complexity may be achieved
Required Qualifications	
Education	Post secondary education is preferred - usually a Bachelors degree in a business field (I.e., business administration, business, management, accounting, marketing, computing and information science). Project managers often have masters degrees, such as a Masters in Business Administration (MBA). A professional designation Project Management Professional (PMP) is often considered an asset.
Training	Project Managers require on-the-job experience; however, typically organizations require that the individual will already

	have the required skills, knowledge, work-related experience, and/or industry courses and programs. Prospective project managers may take project management training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the techniques used in Project Management including current development methodologies such as Waterfall, Agile or Scrum in a health care organization.
Tasks	• Manage multiple inter-related projects • Engage with stakeholders • Create project plans, estimates, schedules and resource plans • Monitor and control project • Risk, issue and financial tracking • Manage change management processes within project • Manage day to day activities for project team • Provide status reports to steering committees and sponsors
Tools and Technology	• Standard Development Lifecycle (SDLC) • Governance Framework • Office productivity and project management software
Required Competencies	
Knowledge	Project Managers should have knowledge of: • Planning tasks and activities • Engaging with stakeholders • Change Management • Systems Management (SDLC, SM disciplines, Governance framework) • Business analysis processes, information and content flow • Health systems in Canada and the different types of healthcare delivery models across the continuum of care and their interrelationships (e.g., hospitals, clinics, ambulatory centres and community health agencies, regional health authorities) • Policies and principles for the management of health information • Relevant health information standards and their appropriate use • How people, resources and information flow through the health system • Roles and relationships of health professionals along with the organizational and regulatory structure in which they work

	• The need to balance the privacy of personal health information with improved care delivery and health system management

Skills	Project Managers should have skills in the following categories:
	
	Technical
	• Thorough knowledge and demonstrable experience of Project Management disciplines including
	  o ability to manage multiple inter-related projects and determine sensitivity and impact of events
	  o project planning: estimating, scheduling, resourcing
	  o project tracking and control including financial tracking
	  o risk & issue management
	• Knowledge of and experience in Change Management
	• Knowledge of and experience in all aspects of systems management including SDLC, SM disciplines, Governance framework
	• Overall knowledge of Business Analysis - general understanding of processes, information content/flow etc.
	• Some knowledge and experience of current development methodologies such as Waterfall, Agile or Scrum
	
	Contextual
	• People management skills – effective supervision and performance management
	• Knowledge and understanding of the operation of healthcare organizations, various stakeholders, and policy
	• Political sensitivity, ability to read issues concerns, agendas of stakeholders
	• Knowledge of and experience in managing projects, programs and teams
	• Some knowledge and understanding relating to financial management and budgeting
	• Some knowledge and understanding relating to procurement and contract negotiations - experience with stakeholder negotiations, contract terms, legal terms and conditions, etc.
	• Understanding of the stakeholders involved in health technology – funders, government, vendors, health care delivery organizations, providers, caregivers and patients

Personal Attributes	• Forge relationships with their organization's upper management • Engage other key stakeholders

	• Ensure proper level of support for the program • Deal with specific issues
Abilities	Project Managers should have the following abilities • Leadership skills, including ability: o To keep the project team members engaged o To keep all other stakeholders engaged o To motivate and inspire project team o To display personal courage and conviction – for example to stop a project if the conditions for success are not present or if business conditions change. • Effective communication skills, both oral and written, including so as to have the ability o To communicate the overall vision to senior management and an audience of stakeholders, o To frame their messaging, so as to emphasize issues and contingency plans clearly o To communicate relevant project information to internal and external stakeholders. • Ability to identify opportunities for improvement and makes constructive suggestions for positive change
Work Values	Individuals who are effective as Project Managers: • Are s□□□□□ communicators • Thrive working in a collaborative team environment • Enjoy problem-solving • Can lead teams that are often multi-disciplinary□
Work Styles	Project Managers would have the following work styles: • Detail oriented • Cooperative • Stress tolerant • Initiative • Independent • Integrity • Multi-tasking • Organised.

5.7- Health Systems Analyst

Occupational Standard (for use in the development of Business Technology Management related job descriptions, performance evaluations, career development plans, educational learning outcomes etc.)	
Description of Position	The Systems Analyst enhances, develops or deploys information systems or information technology solutions to

	achieve improvement in business process outcomes. The Systems Analyst identifies problems, assesses solutions, designs, develops/tests and deploys technology solutions. The Systems Analyst analyzes the users' needs and determines the appropriate solution(s) to address those needs. The Systems Analyst may also supervise or guide the development effort to ensure that the development meets the needs of the users and the standards of the company. The Systems Analyst analysis, designs, plans, executes and evaluates work to time, cost and quality targets.
Position Development	With experience and further skill development senior positions can be obtained within an organization.
Required Competencies	
Training	Systems Analysts require on-the-job training; however, typically organizations require that the individual will already have the required skills, knowledge, work-related experience, and/or industry courses and programs. Some organizations will send individuals to specific enterprise solutions training courses and programs to learn additional tools and techniques.
Related Work Experience	Individuals may have experience in any of the methodologies and techniques used as Systems Analysts in a health care organization.
Tasks	• Enhance, develop and deploy solutions • Identify problems and assess solutions • Tests solutions • Analyses user needs and determine appropriate solution • Supervise development efforts
Tools and Technology	• Standard Development Lifecycle (SDLC) • ITIL • Business Analysis Framework • Governance Framework • Office productivity tools
Required Competencies	
Knowledge	Systems Analysts should have knowledge of: • Systems Management (SDLC, ITIL, Governance framework)

- Development techniques and software configuration
- Architecture development
- Business analysis and business process improvement
- Techniques used for information and data analysis
- Health systems in Canada and the different types of healthcare delivery models across the continuum of care and their interrelationships (e.g., hospitals, clinics, ambulatory centres and community health agencies, regional health authorities).
- Policies and principles for the management of health information
- Relevant health information standards and their appropriate use
- Basic clinical and biomedical concepts, clinical care processes, technologies and workflow for purposes of analysis, design, development and implementation of health information systems and applications.
- Basic clinical terminology and commonly used abbreviations and acronyms.
- Commonly used formats, structures and methods for recording and communicating clinical data and how these are incorporated into system and application use.
- Architectural relationships between key health information technology components (e.g., the Canada Health Infoway EHRS blueprint) and best practices in enterprise architecture frameworks/perspectives.
- The selection and utilization of appropriate information technologies to meet business requirements.
- Appropriate health informatics standards and enterprise models to enable system interoperability (e.g., terminology, data structure, system to system communication, privacy, security, safety).
- Health data, information and workflow models to information technology solutions.
- Key information technology concepts and components (e.g., networks, storage devices, operating systems, information retrieval, data warehousing, applications, firewalls, etc.).
- How people, resources and information flow through the health system.
- Roles and relationships of health professionals along with the organizational and regulatory structure in which they work.

	• The need to balance the privacy of personal health information with improved care delivery and health system management.
Skills	Systems Analysts should have skills in the following categories: Technical • Mastery of system development methodologies, particularly the life cycle of systems development (planning, design, build, test, deploy), best practices, • Understanding of development techniques, or software configuration • Problem solving abilities • Architecture skills • Knowledge and understanding of business analysis/business process improvement • Knowledge and understanding of techniques for information and data analysis • Some knowledge and understanding of IT governance ad of ITIL/SDLC processes Contextual • Full understanding of the organizational environment in which the solutions are being developed. • Critical thinking - ability to use logic and reasoning to identify the strength and weaknesses of alternative solutions in helping to achieve business outcomes • Judgment and decision-making - Considering the relative costs and benefits of potential actions to choose the most appropriate one. • Understands the relevance of her/his own area of responsibility/specialism to the employing organisation. • Understanding of risk analysis, especially as it relates to the context of the organization and the activity • Ability to take initiative to keep skills up to date. • Ability to mentor colleagues in an effective manner. • Maintains an awareness of developments in the industry. • Knowledge and understanding of relevant legislation

Personal Attributes	• People management skills, including performance management of people, development of personnel • Communications skills both oral and written to convey messaging with clarity to the appropriate level of the audience
Abilities	Systems Analyst should have the following abilities • Ability to collaborate with others on the team, ability to work with users and understand their needs • Ability to facilitate collaboration between stakeholders who have diverse objectives • Ability to ask appropriate and effective questions and give full attention to responses, driving to detail • Ability to recognize and be of aware of others' reactions and understanding why they react as they do and the implications to managing changes being proposed
Work Values	Individuals who are effective as Systems Analysts are: • S□□□□ communicators • Thrive working in a collaborative team environment • Enjoy problem-solving Good people management skills□
Work Styles	Systems Analysts would have the following work styles: • Facilitation • Collaborative • Cooperative • Stress tolerant • Initiative • Independent • Integrity
Essential Skills Profile	• Reading text • Document use • Writing skills • Numeracy • Oral Communication • Thinking Skills • Problem Solving • Decision Making • Job Task Planning and Organizing • Significant Use of Memory • Finding Information • Working with Others • Continuous Learning

Appendix F

Extracted: BTM Job Requirements

BTM Job Requirements

The Education Field 2, Education Level 2, Training 2, Experience Field 2, Technical Skills 2 and Soft Skills 2 are removed from this table not as they appeared in the Excell file because they did not fit in this document, and they are almost similar.

BTM Jobs Title	Job Duty pattern	Edu Field 1	EduLevel1	Training 1	Experience Field 1	Exp Years	Technical Skills 1	Soft Skills 1	Lang Certificate Code	Lang Certificate Level
Business Analyst Data Science Analytics	**1**	Computer Science	Bachelor	Specific Enterprise Solutions Training Courses	Business Analysis	4	Information Analysis Techniques	Numeracy	CLB	Intermediate
Data Analyst Data Science Analytics	1	Computer Science	Bachelor	Specific Enterprise Solutions Training Courses	Data Analysis Using RSAS Python	5	Data Concepts	Innovation And Creativity	CLB	Intermediate
Data Scientist Junior Data Science Analytics	1	Business	Bachelor	on the Job Training	Junior Data Scientist	5	Data Analytics Mastery	Numeracy	TCF Canada	Intermediate
Enterprise Data Architect Data Science Analytics	1	Computing	Bachelor	On The Job Training	Enterprise Data Architect	7	Data Technology	Working With Others	TCFC and a	Intermediate
Project Manager Data Science Analytics	2	Business	Bachelor	Professional Certifications PMP	Techniques Used in project Management	10	Project Management	Leadership Skills	CLB	Intermediate
Digital Security Analyst	1	Computer Science	Diploma	on the Job Training	Business Technology	2	Analytical	Reading Comprehension	IELTS	Intermediate
Digital Security Auditor	1	Computer Science	Diploma	Various IT Environment and Cybersecurity	Business Technology	10	Risk Issue Management	Process And Policy Driven	CLB	Intermediate
Digital Security Consultant	1	Computer Science	Diploma	Various IT Environment and Cybersecurity	Consulting	7	Risk Issue Management	Process And Policy Driven	IELTS	Proficient
Digital Security Manager Officer	2	Computer Science	Diploma	Management Training courses	Information Technology	12	Technical Problem Solving	Decision Making	TOEIC	Proficient
Agile Transformation Coach	1	Business Administration	Diploma	Agile Certified Practitioner	Agile Project Management	9	Project Management Frameworks	Active Listening	TOEIC	Proficient
Innovation Consultant	1	Business Administration	Masters	Project Management Professional (PMP)	Technical Project Management	11	Technical Problem Solving	Job Task Planning and Organizing	CELPIP	Proficient
Process Improvement Analyst	1	Business Administration	Bachelor	Six Sigma Training Green lack Master Black Belt	Project Management	6	Conducting In Depth Analysis	Numeracy	TEF Canada	Intermediate
Product Innovation Manager	2	Computing And Information Science	Diploma	Certified Product Manager	Create And Evaluate Business Cases	13	Product Road Mapping	Continuous Learning	IELTS	Proficient
Product Innovation Specialist	1	Commerce	Diploma	Process Improvement Training	Identifying Customer Needs and Market Trends	9	Customer Service Orientation	Self-Starter	TEF Canada	Proficient
Strategic Innovation Manager	2	Commerce	Diploma	Project Management Professional PMP	Project Management	11	Project Design	Strategic Thinker Leadership	TEF Canada	Proficient
Financial Services Cloud Services Manager	2	Business Technology Management	Bachelor	Professional Certifications PMI	Data Service Support Specialist	8	Integration Issue Resolution	Finding Equilibrium	TOEIC	Proficient
Financial Services Enterprise Architect	1	Business Technology Management	Bachelor	Platform Vendor Provided Certifications	Systems Analyst	12	Leadership Ability	Oral Communication	CELPIP	Intermediate
Financial Services IT Governance Risk And Compliance Manager	2	Business Technology Management	Bachelor	Professional Certifications CISA	IT Governance Processes	14	Regulatory Compliance Translation	Writing Skills	TOEIC	Proficient
Financial Services Quality Assurance Specialist	1	Business Technology Management	Diploma	Various IT Environment and QA Scenarios	Systems Analyst	7	Debugging Skills	Thinking Skills	TOEIC	Proficient
Financial Services Cyber Security Specialist	1	Business Technology Management	Bachelor	Platform Vendor Provided Certifications	Cyber security Financial IT	9	Problem And Opportunity Proficiency	Numeracy	IELTS	Proficient

BTM Jobs Title	Job Duty pattern	Edu Field 1	EduLevel1	Training 1	Experience Field 1	Exp Years	Technical Skills 1	Soft Skills 1	Lang Certificate Code	Lang Certificate Level
Health Business Analyst	1	Business	Diploma	On the Job Training	Business Analyst Healthcare	5	Comprehensive Business Analysis	Document Use	CLB	Intermediate
Health Data Analyst	1	Computing And Information Science	Bachelor	Specific Enterprise Solutions Training Courses	Data Analyst Healthcare	3	Data Analytics Mastery	Numeracy	CELPIP	Intermediate
Health Enterprise Architect	1	Business	Bachelor	Professional Certifications In Systems Architect	Enterprise Architect Healthcare	14	Systems Engineering	Innovation And Creativity	CELPIP	Intermediate
Health Enterprise Solutions Manager	2	Business	Diploma	On The Job Training	Enterprise Solutions Management Healthcare	10	Program Management	Leadership Skills	CELPIP	Proficient
Health Information Technology Solutions Developer	1	Computing And Information Science	Bachelor	Certified Product Manager	IT Service Management	8	Programming Server SSRS And SSIS	Problem Solving	TCF Canada	Intermediate
Health Project Manager	2	Business Administration	Masters	Project Management Training Courses	Project Management	10	Project Management	Working With Others	TEF Canada	Proficient
Health Systems Analyst	1	Business	Bachelor	Professional Certifications In Systems Analys	Systems Analyst Healthcare	5	System Development Mastery	Collaboration	TOEIC	Intermediate

Education Requirements and Qualifications:

Education Field	Education Level	Training Certificate
Business Administration	Diploma	Agile Certified Practitioner
Accounting	Bachelor	Certified Associate in Project Management
Business	Masters	Certified Product Manager
Business Administration (MBA)	Doctorate	Certified Scrum Master
Business Technology Management		Various IT Environment and Cybersecurity
Commerce		Various IT Environment and QA Scenarios
Computer Engineering		Industry Courses and Programs
Computer Science		Management Training Courses
Computing		Mobile Apps
Computing And Information Science		On the Job Training
Economics		Process Improvement Training
Engineering		Professional Certifications ACP
Finance		Professional Certifications CGEIT
Legal		Professional Certifications CISA
Management		Professional Certifications CRISC
Marketing		Professional Certifications in BI
Mathematics		Professional Certifications in BPM
Project Management MBA		Professional Certifications in BRMS
Software Development		Professional Certifications in Cloud Technologies
Statistics		Professional Certifications In IT Project Lead Architect
Information Technology		Professional Certifications In Mobile Apps Technologies
		Professional Certifications In PaaS Technologies
		Professional Certifications In Systems Analys
		Professional Certifications In Systems Architect
		Professional Certifications PMI

Education Field	Education Level	Training Certificate
		Professional Certifications PMP
		Professional Certifications Provided By ISACA
		Platform Vendor Provided Certifications
		Professional Certifications RMP
		Project Management Lean Six Sigma
		Project Management or Process Improvement
		Project Management Professional PMP
		Project Management Training Courses
		Six Sigma Training Green lack Master Black Belt
		Specific Enterprise Solutions Training Courses
		Various IT Environment and QA Scenarios

Experience Requirements:

Experience Field	Experience Years	Experience Level
Agile In Health Care Organization	1	Entry Level
Agile Project Management	2	Junior
Business Administration	3	Intermediate
Business Analysis	4	Senior
Business Analyst Healthcare	5	Manager
Business Experience	6	Executive
Business Processes	7	
Business Requirement Specification	8	
Business Technology	9	
Communicating With Senior Management	10	
Conducting Training Sessions	11	
Consulting	12	
Coordinating Tasks And Project Efforts	13	
Create And Evaluate Business Cases	14	
Cybersecurity Financia IT	15	
Cybersecurity Audit	16	
Data Administration Experience	17	
Data Analysis Experience	18	
Data Analysis Using RSAS Python	19	
Data Analyst Healthcare	20	
Data Service Support Specialist	21	
Designing Customer Solutions	22	
Development Agile Scrum	23	
Distributed Computing Basics	24	
Enterprise Architect Healthcare	25	
Enterprise Data Architect	26	

Experience Field	Experience Years	Experience Level
Enterprise Solutions Management Healthcare	27	
Facilitating Training Sessions	28	
Feature Management	29	
Focus Groups	30	
Gap Analysis		
General Purpose Programming Language		
Identifying Customer Needs And Market Trends		
Information Technology Experience		
Information Technology In Health Care Setting		
Internal Consulting		
IT Configuration Management		
IT Governance Processes		
IT Operations And Support Roles		
IT Project Delivery		
IT Project Lead Architect		
IT Service Management		
IT Solutions Architect Healthcare		
IT Support		
Junior Data Scientist		
Junior Statistician		
Leading Agile Projects		
Managing Cross Functional Teams		
Manipulating Large Datasets And Using Databases		
Marketing Strategy		
Modelling		
Operations And Sales And Distribution		
Process Flow ChartsAnd Diagrams		
Process Improvement		
Product Road Mapping		
Programming Language Hadoop MapReduce		
Programming Language Java		
Project Management		
Project Management And Supervisory		
Project Review		
Qualification And Assurance		
Quality Assurance Specialist		
Regulatory Compliance		
Requirements Gathering		
Risk Management		
Road Mapping Experience		
Root Cause Analysis		
Security Related Discipline		

Experience Field	Experience Years	Experience Level
Software Engineering		
Statistical Packages		
Swimlane Diagrams		
Systems Analyst		
Systems Analyst Healthcare		
Systems Architect		
Technical Project Management		
Technical Support		
Technical Writing		
Techniques Used In Project Management		
Testing Specialist		
Vendor Relationship Specialist		
Waterfall Project Management		
Working In Cross Functional Teams		

Skills Requirements:

Soft Skills	Tech Skills
Active Listening	Agile Methodology
Adaptability	Analytical
Ambitious	Analytics Platforms
Coaching Skills	Architectural Standards Methodologies
Collaboration	Articulate Problems And Building Solutions
Communication Skills	Automated Testing Proficiency
Concern For Others	Big Data Architecture
Continuous Learning	Big Data Concepts
Cooperation	Big Data Ecosystems
Deal With Specific Issues	Big Data Technology
Decision Making	Business Analysis
Delegation Skills	Business Analysis Techniques
Dependability	Business And Regulatory Acumen
Document Use	Business Casing
Dominant Within The Organization	Business Process Improvement
Engage Other Key Stakeholders	Business Tech Domain Acumen
Guarantee Program Support	Change Management
Facilitation	Client Relations
Finding Equilibrium	Client Side Ajax Mastery
Finding Information	Client Side CSS Mastery
Flexibility	Client Side HTML5 Mastery
Connect With Executives	Client Side Java Script Mastery
High Level Thinking	Client Side JQuert Mastery
Independent	Client Side JSON Mastery

Soft Skills	Tech Skills
Inductive And Deductive Reasoning	Complex Data Analytics Mastery
Informative	Comprehensive Business Analysis
Initiative	Conducting In Depth Analysis
Innovation	Conflict Management
Innovation And Creativity	Continuous Integration Practice
Integrity	Coordination
Job Task Planning And Organizing	Cost Benefit Analysis
Leadership Skills	Cost Management
Numeracy	Critical Review
Oral Communication	Critical Thinking
Oral Expression And Comprehension	Customer Pain Point Recognition
Outside The Box Thinking	Customer Service Orientation
People Management	Data Analysis Techniques
Persistence	Data Analytics
Planning Skills	Data Analytics Mastery
Planning Supervision Coaching And Delegation Skills	Big Data Technology
Presentation And Public Speaking Skills	Database Technologies
Prioritization	Data Concepts
Problem Sensitivity	Data Configuration
Problem Solving	Data Science
Process And Policy Driven	Data Technology
Rapport Building And Networking	Data Technology
Reading Comprehension	Debugging Skills
Reading Text	Technical Decision Making
Research Skills	Details Oriented
Self Starter	Development Methodologies
Significant Use Of Memory	Diagnostic And Problem Solving
Social Perceptiveness	Distributed Architecture Mastery
Speaking	Emotional Intelligence
Strategic Thinker Leadership	Enterprise Architecture And Methodologies
Stress Tolerant	Experimental Design Mastery
Supervision Skills	Experimental Thinking
Take Initiative	Focus Group Facilitation
Thinking Skills	Identifying Bottlenecks
Vision	Information Analysis Techniques
Working With Others	Infrastructure Specifying
Writing Skills	Integration Issue Resolution
	Intelligence Programs
	Interpersonal Communication
	IT Governance
	IT Governance In ITIL And SDLC

Soft Skills	Tech Skills
	IT Investment Financial Modeling
	Leadership Presentation
	Leading Project Teams
	Management Process By ITIL
	Modeling Techniques And Methods
	Networking And System Architecture
	Opportunity Identification
	Political Acumen
	Presentation And Negotiation Proficiency
	Pressure Handling
	Problem And Opportunity Proficiency
	Technical Problem Solving
	Process Improvement
	Product Road Mapping
	Program Management
	Programming ASP Net
	Programming C Sharp
	Programming Microsoft SQL
	Programming Power BI
	Programming Server SSRS And SSIS
	Programming Share Point
	Programming Skills
	Programming VB Net
	Programming Visual Studio
	Project Control And Financial Tracking
	Project Design
	Project Management
	Project Management Frameworks
	Project Planning
	Proposal Writing
	Quality Assurance
	Rapid Technical Absorption
	Regulatory Compliance Translation
	Requirements Techniques And Management
	Results Driven Proactivity
	Risk Issue Management
	Service Orientation
	SMES Collaboration
	Software Configuration
	Software Development
	Software Engineering
	Software Framework Optimization

Soft Skills	Tech Skills
	Software Tuning
	Stakeholder Analysis
	Statistical Pattern Recognition
	Strategic Mindset
	Strategic Planning
	System And Integration Testing
	System Development Mastery
	System Development Methodologies
	Systems Analysis
	Systems Design Techniques
	Systems Engineering
	Systems Engineering Thinking
	Systems Management SDLCSM Governance
	Systems Thinking
	Team And Time Management
	Team Collaboration
	Team Leadership
	Teamwork
	Technical Training
	Technology Strategy
	Test Automation Tools
	Testing Approaches And Techniques
	Timely Decision Making
	Time Management And Prioritization
	Training Hosting
	Vendor And Tech Procurement
	Vendor Selection

Languages Requirements:

Lang Certificate ode	Lang Certificate Name	Lang Certificate Level
CELPIP	Canadian English Language Proficiency Index Program	Basic
IELTS	International English Language Testing System	Intermediate
TOEIC	Test Of English For International Communication	Proficient
CLB	Canadian Language Benchmark	
TEF Canada	Test D'évaluation De Français	
TCF Canada	Test De Connaissance Du Français	

Appendix G

Generated: Job Posting and Job Seekers

Job Posting Requirements:

Job Posting No	BTM Job Title	Organization Name	Posted Date	Last Apply Date	job Working Shift	Job Type	Available Positions	Job Salary
JPosting1	Digital Security Manager Officer	Desjardins Group	8/25/2024	12/25/2024	Morning	Full Time	1	199512.00
JPosting2	Business Analyst Data Science Analytics	Amazon	8/26/2024	12/26/2024	Morning	Full Time	2	86000.00
JPosting3	Innovation Consultant	Bell Canada	8/27/2024	12/27/2024	Morning	Full Time	1	60000.00
JPosting4	Financial Services Quality Assurance Specialist	Bank Of Montreal	8/28/2024	12/28/2024	Morning	Full Time	2	64628.00
JPosting5	Health Project Manager	Enbridge	8/29/2024	12/29/2024	Morning	Full Time	1	81563.00
JPosting6	Data Analyst Data Science Analytics	Brookfield Asset Management	8/30/2024	12/30/2024	Morning	Full Time	1	87248.00
JPosting7	Digital Security Analyst	Constellation Software	8/31/2024	12/31/2024	Morning	Full Time	1	90000.00
JPosting8	Agile Transformation Coach	Toronto Dominion Bank	9/1/2024	1/1/2025	Morning	Full Time	1	145028.00
JPosting9	Financial Services Enterprise Architect	Brookfield Asset Management	9/2/2024	1/2/2025	Morning	Full Time	2	114253.00
JPosting10	Enterprise Data Architect Data Science Analytics	TC Energy	9/3/2024	1/3/2025	Morning	Full Time	2	104999.00
JPosting11	Digital Security Auditor	University Of Ottawa	9/4/2024	1/4/2025	Morning	Full Time	1	77800.00
JPosting12	Digital Security Consultant	Canadian National Railway	9/5/2024	1/5/2025	Morning	Full Time	1	111123.00
JPosting13	Health Enterprise Architect	Hydro Quebec	9/6/2024	1/6/2025	Morning	Full Time	3	106848.00
JPosting14	Financial Services Cloud Services Manager	Intact Financial	9/7/2024	1/7/2025	Morning	Full Time	1	82030.00
JPosting15	Strategic Innovation Manager	Loblaws	9/8/2024	1/8/2025	Morning	Full Time	1	81254.00
JPosting16	Health Information Technology Solutions Developer	Manulife Financial Corporation	9/9/2024	1/9/2025	Morning	Full Time	4	114253.00
JPosting17	Project Manager Data Science Analytics	Scotiabank	9/10/2024	1/10/2025	Morning	Full Time	1	95040.00
JPosting18	Product Innovation Manager	Air Canada	9/11/2024	1/11/2025	Morning	Full Time	1	81254.00
JPosting19	Financial Services IT Governance Risk and Compliance Manager	Carleton University	9/12/2024	1/12/2025	Morning	Full Time	1	175750.00
JPosting20	Health Data Analyst	Imperial Oil	9/13/2024	1/13/2025	Morning	Full Time	2	75000.00
JPosting21	Process Improvement Analyst	Thomson Reuters	9/14/2024	1/14/2025	Morning	Full Time	2	105000.00
JPosting22	Data Scientist Junior Data Science Analytics	Bell Canada	9/15/2024	1/15/2025	Morning	Full Time	2	64193.00
JPosting23	Product Innovation Specialist	Kinova	9/16/2024	1/16/2025	Morning	Full Time	2	66801.00
JPosting24	Financial Services Cyber Security Specialist	University Of Quebec Outaouais	9/17/2024	1/17/2025	Morning	Full Time	2	103684.00
JPosting25	Health Business Analyst	CIBC	9/17/2024	1/18/2025	Morning	Full Time	2	71166.00
JPosting26	Health Enterprise Solutions Manager	IBM	9/17/2024	1/19/2025	Morning	Full Time	1	71166.00
JPosting27	Health Systems Analyst	University Of Quebec Outaouais	9/17/2024	1/20/2025	Morning	Full Time	1	75878.00

Job Seekers Qualifications:

The Education Field 2, Education Level 2, Training 2, Experience Field 2, Technical Skills 2, Soft Skills 2, Name, Age, Sex and Marital Status are removed from this table not as they appeared in the Excell file because they did not fit in this document, and they are almost similar.

Job Seeker	Apply To JPosting	Apply To BTM Job Title	Edu Field	Edu Level	Training1	Experience Field1	Exp Years	Technical Skills1	Soft Skill1	Lang Certificate Code	Lang Certificate Level
JSeeker1	JPosting1	Digital Security Manager Officer	Computer Science	Diploma	Management Training Courses	Information Technology	10	Technical Problem Solving	Decision Making	TOEIC	Proficient
JSeeker2	JPosting1	Digital Security Manager Officer	Information Technology	Diploma	Nil	Information Technology	7	Technical Problem Solving	Finding Information	TOEIC	Intermediate
JSeeker3	JPosting1	Digital Security Manager Officer	Computer Science	Bachelor	Project Management Lean Six Sigma	Process Improvement	6	Risk Issue Management	Decision Making	CELPIP	Intermediate
JSeeker4	JPosting1	Digital Security Manager Officer	Business Technology Management	Masters	Project Management Professional	Business Processes	9	Business Casing	Cooperation	IELTS	Proficient
JSeeker5	JPosting1	Digital Security Manager Officer	Computing And Information Science	Diploma	Various IT Environment And Cybersecurity	Security Related Discipline	8	Analytical	Process And Policy Driven	TEF Canada	Proficient
JSeeker6	JPosting1	Digital Security Manager Officer	Business Administration	Bachelor	Specific Enterprise Solutions Training Courses	Information Technology	7	Technical Problem Solving	Inductive And Deductive Reasoning	CLB	Intermediate
JSeeker7	JPosting2	Business Analyst Data Science Analytics	Computing And Information Science	Bachelor	Industry Courses And Programs	IT Service Management	3	Business Analysis Techniques	Reading Text	CELPIP	Proficient
JSeeker8	JPosting2	Business Analy t Data Science Analytics	Business Administration	Diploma	Nil	Data Analysis	5	Analytical	Document Use	TCF Canada	Intermediate
JSeeker9	JPosting2	Business Analyst Data Science Analytics	Computer Science	Bachelor	Specific Enterprise Solutions Training Courses	Business Analysis	3	Information Analysis Techniques	Numeracy	CLB	Intermediate
JSeeker10	JPosting2	Business Analyst Data Science Analytics	Information Technology	Masters	Various IT Environment And QA Scenarios	Information Technology	4	Technical Problem Solving	Supervision Skills	IELTS	Proficient
JSeeker11	JPosting2	Business Analyst Data Science Analytics	Business Administration	Bachelor	Nil	Business Processes	1	Business Casing	Strategic Thinker Leadership	TOEIC	Intermediate
JSeeker12	JPosting2	Business Analyst Data Science Analytics	Computer Science	Doctorate	Specific Enterprise Solutions Training Courses	Business Analysis	3	Information Analysis Techniques	Numeracy	CLB	Intermediate
JSeeker13	JPosting2	Business Analyst Data Science Analytics	Business Technology Management	Bachelor	Project Management Training Courses	Nil	0	Project Management	Prioritization	Nil	Nil
JSeeker14	JPosting3	Innovation Consultant	Business Administration	Masters	Project Management Lean Six Sigma	Business Administration Experience	6	Leadership Ability	Flexibility	TEF Canada	Proficient
JSeeker15	JPosting3	Innovation Consultant	Business Administration	Masters	Project Management Professional	Technical Project Management	5	Technical Problem Solving	Job Task Planning And Organizing	CELPIP	Proficient
JSeeker16	JPosting3	Innovation Consultant	Computer Science	Bachelor	Management Training Courses	Nil	0	Project Management	Numeracy	IELTS	Intermediate
JSeeker17	JPosting3	Innovation Consultant	Information Technology	Masters	Project Management Professional	Information Technology	5	Analytical	Job Task Planning And Organizing	TOEIC	Proficient
JSeeker18	JPosting3	Innovation Consultant	Business Technology Management	Bachelor	Industry Courses And Programs	Technical Project Management	3	Technical Problem Solving	Decision Making	CLB	Intermediate
JSeeker19	JPosting3	Innovation Consultant	Business Administration	Masters	Project Management Professional	Technical Project Management	5	Technical Problem Solving	Job Task Planning And Organizing	CELPIP	Proficient
JSeeker20	JPosting4	Financial Services Quality Assurance Specialist	Business Technology Management	Bachelor	Project Management Training Courses	Business Technology Experience	6	Project Management Frameworks	Job Task Planning And Organizing	TOEIC	Proficient
JSeeker21	JPosting4	Financial Services Quality Assurance Specialist	Computer Science	Diploma	Specific Enterprise Solutions Training Courses	Testing Specialist	5	Debugging And Diagnostic Skill	Oral Communication	TCF Canada	Intermediate
JSeeker22	JPosting4	Financial Services Quality Assurance Specialist	Business Technology Management	Diploma	Various IT Environment And QA Scenarios	Systems Analyst	7	Debugging Skills	Thinking Skills	TOEIC	Proficient
JSeeker23	JPosting4	Financial Services Quality Assurance Specialist	Information Technology	Masters	Various IT Environment And QA Scenarios	Information Technology	7	Technical Problem Solving	Innovation And Creativity	CELPIP	Intermediate

Job Seeker	Apply To JPosting	Apply To BTM Job Title	Edu Field	Edu Level	Training1	Experience Field1	Exp Years	Technical Skills1	Soft Skill1	Lang Certificate Code	Lang Certificate Level
JSeeker24	JPosting5	Health Project Manager	Business Administration	Bachelor	Specific Enterprise Solutions Training Courses	Development Agile Scrum	4	Project Management Frameworks	Job Task Planning And Organizing	TCF Canada	Intermediate
JSeeker25	JPosting5	Health Project Manager	Business Administration	Masters	Project Management Training Courses	Project Management	6	Project Management	Working With Others	TEF Canada	Proficient
JSeeker26	JPosting5	Health Project Manager	Commerce	Masters	Industry Courses And Programs	Technical Project Management	7	Technical Problem Solving	Numeracy	IELTS	Proficient
JSeeker27	JPosting5	Health Project Manager	Business Technology Management	Bachelor	Project Management Training Courses	Project Management	5	Team And Time Management	Document Use	CELPIP	Intermediate
JSeeker28	JPosting5	Health Project Manager	Business Administration	Masters	Project Management Training Courses	Project Management	6	Project Management	Working With Others	TEF Canada	Proficient
JSeeker29	JPosting6	Data Analyst Data Science Analytics	Commerce	Bachelor	Management Training Courses	Junior Statistician	3	Data Concepts	Decision Making	TOEIC	Intermediate
JSeeker30	JPosting6	Data Analyst Data Science Analytics	Computing	Masters	Project Management Training Courses	Project Management	5	Business Casing	Innovation And Creativity	CLB	Proficient
JSeeker31	JPosting6	Data Analyst Data Science Analytics	Computer Science	Bachelor	Specific Enterprise Solutions Training Courses	Data Analysis Using RSAS Python	4	Data Concepts	Innovation And Creativity	CLB	Intermediate
JSeeker32	JPosting6	Data Analyst Data Science Analytics	Information Technology	Bachelor	Various IT Environment And QA Scenarios	Technical Project Management	3	Project Management	Job Task Planning And Organizing	CELPIP	Intermediate
JSeeker33	JPosting6	Data Analyst Data Science Analytics	Computer Science	Bachelor	Specific Enterprise Solutions Training Courses	Data Analysis Using RSAS Python	4	Data Concepts	Innovation And Creativity	CLB	Intermediate
JSeeker34	JPosting6	Data Analyst Data Science Analytics	Computer Science	Diploma	Nil	Data Analysis Using RSAS Python	2	Technical Problem Solving	Thinking Skills	TCF Canada	Proficient
JSeeker35	JPosting6	Data Analyst Data Science Analytics	Business Administration	Bachelor	Specific Enterprise Solutions Training Courses	Data Analysis Using RSAS Python	4	Data Concepts	Innovation And Creativity	CLB	Intermediate
JSeeker36	JPosting7	Digital Security Analyst	Computer Science	Diploma	Various IT Environment And QA Scenarios	Information Technology	6	Analytical	Oral Communication	TOEIC	Proficient
JSeeker37	JPosting7	Digital Security Analyst	Business Technology Management	Bachelor	Industry Courses And Programs	Business Technology Experience	4	Team And Time Management	Decision Making	TEF Canada	Intermediate
JSeeker38	JPosting7	Digital Security Analyst	Business Technology Management	Diploma	On The Job Training	Business Technology Experience	5	Analytical	Reading Comprehension	IELTS	Intermediate
JSeeker39	JPosting8	Agile Transformation Coach	Computer Science	Diploma	Agile Certified Practitioner	Agile Project Management	4	Project Management Frameworks	Active Listening	TOEIC	Proficient
JSeeker40	JPosting8	Agile Transformation Coach	Business Administration	Bachelor	Nil	Business Technology Experience	3	Business Casing	Numeracy	CELPIP	Intermediate
JSeeker41	JPosting8	Agile Transformation Coach	Computer Science	Diploma	Agile Certified Practitioner	Agile Project Management	4	Project Management Frameworks	Active Listening	TOEIC	Proficient
JSeeker42	JPosting8	Agile Transformation Coach	Information Technology	Masters	Professional Certifications ACP	Agile Project Management	5	Technical Problem Solving	Innovation And Creativity	IELTS	Proficient
JSeeker43	JPosting8	Agile Transformation Coach	Computer Science	Diploma	Agile Certified Practitioner	Project Management	4	Project Management Frameworks	Active Listening	TOEIC	Intermediate
JSeeker44	JPosting9	Financial Services Enterprise Architect	Business Technology Management	Bachelor	Nil	Business Technology Experience	9	Leadership Ability	Oral Communication	TCF Canada	Proficient
JSeeker45	JPosting9	Financial Services Enterprise Architect	Computer Science	Masters	Platform Vendor Provided Certifications	IT Project Lead Architect	15	Data Concepts	Innovation And Creativity	CLB	Proficient
JSeeker46	JPosting9	Financial Services Enterprise Architect	Business Technology Management	Bachelor	Platform Vendor Provided Certifications	Systems Analyst	15	Leadership Ability	Oral Communication	CELPIP	Intermediate

Job Seeker	Apply To JPosting	Apply To BTM Job Title	Edu Field	Edu Level	Training1	Experience Field1	Exp Years	Technical Skills1	Soft Skill1	Lang Certificate Code	Lang Certificate Level
JSeeker47	JPosting9	Financial Services Enterprise Architect	Information Technology	Diploma	Industry Courses And Programs	Information Technology	10	Results Driven Proactivity	Working With Others	TEF Canada	Proficient
JSeeker48	JPosting9	Financial Services Enterprise Architect	Computer Science	Bachelor	Platform Vendor Provided Certifications	IT Support	15	Leadership Ability	Oral Communication	CELPIP	Intermediate
JSeeker49	JPosting9	Financial Services Enterprise Architect	Computing And Information Science	Bachelor	Project Management Training Courses	Business Administration Experiance	11	Business Casing	Social Perceptiveness	TOEIC	Intermediate
JSeeker50	JPosting9	Financial Services Enterprise Architect	Business Technology Management	Bachelor	Platform Vendor Provided Certifications	Systems Analyst	15	Leadership Ability	Oral Communication	CELPIP	Intermediate
JSeeker51	JPosting9	Financial Services Enterprise Architect	Business Technology Management	Diploma	Specific Enterprise Solutions Training Courses	Systems Analyst	16	Information Analysis Techniques	Job Task Planning And Organizing	IELTS	Proficient
JSeeker52	JPosting9	Financial Services Enterprise Architect	Computer Science	Bachelor	Platform Vendor Provided Certifications	Systems Analyst	15	Leadership Ability	Oral Communication	CELPIP	Intermediate
JSeeker53	JPosting10	Enterprise Data Architect Data Science Analytics	Business	Bachelor	On The Job Training	Enterprise Data Architect	4	Data Technology	Working With Others	TCF Canada	Intermediate
JSeeker54	JPosting10	Enterprise Data Architect Data Science Analytics	Computing	Diploma	On The Job Training	Systems Analyst	3	Data Concepts	Reading Comprehension	IELTS	Proficient
JSeeker55	JPosting10	Enterprise Data Architect Data Science Analytics	Business	Bachelor	Specific Enterprise Solutions Training Courses	Enterprise Data Architect	2	Development Methodologies	Working With Others	CELPIP	Intermediate
JSeeker56	JPosting10	Enterprise Data Architect Data Science Analytics	Computing	Bachelor	On The Job Training	Enterprise Data Architect	4	Data Technology	Working With Others	TCF Canada	Intermediate
JSeeker57	JPosting11	Digital Security Auditor	Business Technology Management	Bachelor	Management Training Courses	Business Technology Experience	10	Systems Engineering Thinking	Social Perceptiveness	TEF Canada	Proficient
JSeeker58	JPosting11	Digital Security Auditor	Computer Science	Diploma	Various IT Environment And Cybersecurity	Business Technology Experience	10	Risk Issue Management	Process And Policy Driven	CLB	Intermediate
JSeeker59	JPosting11	Digital Security Auditor	Computer Science	Bachelor	On The Job Training	Systems Analyst	11	Risk Issue Management	Process And Policy Driven	TOEIC	Proficient
JSeeker60	JPosting11	Digital Security Auditor	Business Technology Management	Diploma	Various IT Environment And Cybersecurity	Business Technology Experience	10	Risk Issue Management	Process And Policy Driven	CLB	Intermediate
JSeeker61	JPosting11	Digital Security Auditor	Computer Science	Diploma	Various IT Environment And Cybersecurity	Business Technology Experience	10	Risk Issue Management	Process And Policy Driven	CLB	Intermediate
JSeeker62	JPosting11	Digital Security Auditor	Business Administration	Diploma	Industry Courses And Programs	Business Administration Experience	9	Data Technology	Active Listening	TEF Canada	Proficient
JSeeker63	JPosting11	Digital Security Auditor	Computer Science	Diploma	Various IT Environment And Cybersecurity	Business Technology Experience	10	Risk Issue Management	Process And Policy Driven	CLB	Intermediate
JSeeker64	JPosting11	Digital Security Auditor	Information Technology	Bachelor	Various IT Environment And Cybersecurity	IT Project Lead Architect	7	Systems Engineering Thinking	Numeracy	IELTS	Intermediate
JSeeker65	JPosting11	Digital Security Auditor	Business Technology Management	Bachelor	Project Management Training Courses	Business Technology Experience	12	Leadership Ability	Process And Policy Driven	CELPIP	Proficient
JSeeker66	JPosting11	Digital Security Auditor	Computer Science	Diploma	Various IT Environment And Cybersecurity	Business Technology Experience	10	Risk Issue Management	Process And Policy Driven	CLB	Intermediate
JSeeker67	JPosting11	Digital Security Auditor	Business Technology Management	Diploma	Various IT Environment And Cybersecurity	Business Technology Experience	10	Risk Issue Management	Process And Policy Driven	CLB	Intermediate
JSeeker68	JPosting12	Digital Security Consultant	Business Administration	Diploma	Various IT Environment And Cybersecurity	Consulting	7	Risk Issue Management	Process And Policy Driven	IELTS	Proficient
JSeeker69	JPosting12	Digital Security Consultant	Computer Science	Bachelor	Management Training Courses	Consulting	6	Leadership Ability	Inductive And Deductive Reasoning	TOEIC	Intermediate
JSeeker70	JPosting12	Digital Security Consultant	Business Administration	Diploma	Various IT Environment	Consulting	7	Risk Issue Management	Process And Policy Driven	IELTS	Proficient

Job Seeker	Apply To JPosting	Apply To BTM Job Title	Edu Field	Edu Level	Training1	Experience Field1	Exp Years	Technical Skills1	Soft Skill1	Lang Certificate Code	Lang Certificate Level
					And Cybersecurity						
JSeeker71	JPosting12	Digital Security Consultant	Business Administration	Bachelor	Specific Enterprise Solutions Training Courses	Business Administration Experience	8	Risk Issue Management	Process And Policy Driven	TEF Canada	Proficient
JSeeker72	JPosting13	Health Enterprise Architect	Computing And Information Science	Bachelor	Professional Certifications In Systems Architect	Enterprise Architect Healthcare	3	Systems Engineering	Innovation And Creativity	CELPIP	Intermediate
JSeeker73	JPosting13	Health Enterprise Architect	Business	Diploma	Industry Courses And Programs	Enterprise Architect Healthcare	2	Customer Service Orientation	Innovation And Creativity	TOEIC	Proficient
JSeeker74	JPosting13	Health Enterprise Architect	Business	Bachelor	Professional Certifications In Systems Architect	Enterprise Architect Healthcare	3	Systems Engineering	Innovation And Creativity	CELPIP	Intermediate
JSeeker75	JPosting13	Health Enterprise Architect	Computer Science	Bachelor	Management Training Courses	Business Technology Experience	4	Risk Issue Management	Decision Making	TCF Canada	Proficient
JSeeker76	JPosting13	Health Enterprise Architect	Computing And Information Science	Diploma	Professional Certifications In Systems Architect	Nil	0	Systems Engineering	Process And Policy Driven	IELTS	Intermediate
JSeeker77	JPosting13	Health Enterprise Architect	Business	Bachelor	Professional Certifications In Systems Architect	Enterprise Architect Healthcare	3	Systems Engineering	Innovation And Creativity	CELPIP	Intermediate
JSeeker78	JPosting14	Financial Services Cloud Services Manager	Business Technology Management	Diploma	Professional Certifications PMI	Data Service Support Specialist	16	Management Process By ITIL	Finding Equilibrium	CLB	Intermediate
JSeeker79	JPosting14	Financial Services Cloud Services Manager	Business Technology Management	Bachelor	Professional Certifications PMI	Data Service Support Specialist	15	Integration Issue Resolution	Finding Equilibrium	TOEIC	Proficient
JSeeker80	JPosting14	Financial Services Cloud Services Manager	Information Technology	Bachelor	Professional Certifications In Systems Architect	Vendor Relationship Specialist	13	Systems Engineering	Innovation And Creativity	IELTS	Proficient
JSeeker81	JPosting14	Financial Services Cloud Services Manager	Business Technology Management	Bachelor	Professional Certifications PMI	Data Service Support Specialist	15	Integration Issue Resolution	Finding Equilibrium	TOEIC	Proficient
JSeeker82	JPosting14	Financial Services Cloud Services Manager	Business Technology Management	Bachelor	Professional Certifications PMI	Data Service Support Specialist	15	Integration Issue Resolution	Finding Equilibrium	TOEIC	Proficient
JSeeker83	JPosting14	Financial Services Cloud Services Manager	Business Administration	Masters	Specific Enterprise Solutions Training Courses	Data Service Support Specialist	11	Integration Issue Resolution	Decision Making	TEF Canada	Intermediate
JSeeker84	JPosting14	Financial Services Cloud Services Manager	Business Technology Management	Bachelor	Professional Certifications PMI	Data Service Support Specialist	15	Integration Issue Resolution	Finding Equilibrium	TOEIC	Proficient
JSeeker85	JPosting15	Strategic Innovation Manager	Commerce	Bachelor	Project Management Or Process Improvement	Project Management	12	Cost Benefit Analysis	Innovation	CELPIP	Proficient
JSeeker86	JPosting15	Strategic Innovation Manager	Computer Science	Diploma	Project Management Professional PMP	Project Management	10	Designing Cross Departmental Projects	Strategic Thinker Leadership	TEF Canada	Proficient
JSeeker87	JPosting15	Strategic Innovation Manager	Computer Science	Bachelor	Professional Certifications In BI	Marketing Strategy	8	Designing Cross Departmental Projects	Finding Equilibrium	IELTS	Intermediate
JSeeker88	JPosting15	Strategic Innovation Manager	Commerce	Diploma	Project Management Professional PMP	Project Management	10	Designing Cross Departmental Projects	Strategic Thinker Leadership	TEF Canada	Proficient
JSeeker89	JPosting16	Health Information Technology Solutions Developer	Business	Diploma	Certified Product Manager	IT Service Management	4	Programming VB Net	Problem Solving	TOEIC	Intermediate
JSeeker90	JPosting16	Health Information Technology Solutions Developer	Management	Bachelor	Certified Product Manager	IT Service Management	5	Programming Server SSRS And SSIS	Problem Solving	TCF Canada	Intermediate
JSeeker91	JPosting16	Health Information Technology Solutions Developer	Computing And Information Science	Bachelor	Professional Certifications CISA	IT Service Management	6	Programming Server SSRS And SSIS	Problem Solving	CLB	Proficient
JSeeker92	JPosting17	Project Manager Data Science Analytics	Business	Masters	Professional Certifications PMP	Techniques Used In	4	Project Management	Leadership Skills	CLB	Intermediate

Job Seeker	Apply To JPosting	Apply To BTM Job Title	Edu Field	Edu Level	Training1	Experience Field1	Exp Years	Technical Skills1	Soft Skill1	Lang Certificate Code	Lang Certificate Level
						Project Management					
JSeeker93	JPosting17	Project Manager Data Science Analytics	Computing	Masters	Professional Certifications PMP	Data Analysis	3	Systems Engineering Thinking	Leadership Skills	IELTS	Intermediate
JSeeker94	JPosting17	Project Manager Data Science Analytics	Business	Bachelor	Professional Certifications PMP	Techniques Used In Project Management	4	Project Management	Leadership Skills	CLB	Intermediate
JSeeker95	JPosting17	Project Manager Data Science Analytics	Business Technology Management	Bachelor	Project Management Training Courses	Techniques Used In Project Management	5	Project Management	Decision Making	TCF Canada	Proficient
JSeeker96	JPosting17	Project Manager Data Science Analytics	Computing	Bachelor	Professional Certifications PMP	Techniques Used In Project Management	4	Project Management	Leadership Skills	CLB	Intermediate
JSeeker97	JPosting18	Product Innovation Manager	Marketing	Bachelor	Certified Product Manager	Marketing Strategy	11	Product Road Mapping	Finding Equilibrium	TOEIC	Proficient
JSeeker98	JPosting18	Product Innovation Manager	Computing And Information Science	Diploma	Certified Product Manager	Create And Evaluate Business Cases	10	Product Road Mapping	Continuous Learning	IELTS	Proficient
JSeeker99	JPosting18	Product Innovation Manager	Marketing	Diploma	Certified Product Manager	Create And Evaluate Business Cases	10	Product Road Mapping	Continuous Learning	IELTS	Proficient
JSeeker100	JPosting18	Product Innovation Manager	Computing And Information Science	Masters	Project Management Training Courses	Create And Evaluate Business Cases	7	Analytical	Innovation And Creativity	TCF Canada	Intermediate
JSeeker101	JPosting18	Product Innovation Manager	Computing And Information Science	Diploma	Certified Product Manager	Create And Evaluate Business Cases	10	Product Road Mapping	Continuous Learning	IELTS	Proficient
JSeeker102	JPosting18	Product Innovation Manager	Computer Science	Bachelor	Specific Enterprise Solutions Training Courses	Create And Evaluate Business Cases	9	Leadership Ability	Continuous Learning	CELPIP	Intermediate
JSeeker103	JPosting18	Product Innovation Manager	Marketing	Diploma	Certified Product Manager	Create And Evaluate Business Cases	10	Product Road Mapping	Continuous Learning	IELTS	Proficient
JSeeker104	JPosting19	Financial Services IT Governance Risk And Compliance Manager	Business Technology Management	Bachelor	Professional Certifications CISA	Technical Project Management	13	Risk Issue Management	Problem Solving	CLB	Intermediate
JSeeker105	JPosting19	Financial Services IT Governance Risk And Compliance Manager	Business Technology Management	Bachelor	Professional Certifications CISA	IT Governance Processes	15	Regulatory Compliance Translation	Writing Skills	TOEIC	Proficient
JSeeker106	JPosting19	Financial Services IT Governance Risk And Compliance Manager	Business	Diploma	Management Training Courses	IT Governance Processes	17	Regulatory Compliance Translation	Writing Skills	TEF Canada	Proficient
JSeeker107	JPosting19	Financial Services IT Governance Risk And Compliance Manager	Business Technology Management	Bachelor	Professional Certifications CISA	IT Governance Processes	15	Regulatory Compliance Translation	Writing Skills	TOEIC	Proficient
JSeeker108	JPosting20	HealthDataAnalyst	Statistics	Bachelor	Specific Enterprise Solutions Training Courses	Data Analyst Healthcare	3	Data Analytics Mastery	Numeracy	CELPIP	Intermediate
JSeeker109	JPosting20	Health Data Analyst	Computing And Information Science	Masters	Professional Certifications PMP	Nil	0	Big Data Ecosystems	Thinking Skills	TCF Canada	Intermediate
JSeeker110	JPosting20	Health Data Analyst	Computing And Information Science	Bachelor	Specific Enterprise Solutions Training Courses	Data Analyst Healthcare	3	Data Analytics Mastery	Numeracy	CELPIP	Intermediate
JSeeker111	JPosting20	Health Data Analyst	Marketing	Diploma	Certified Product Manager Certified Product Manager	Data Analyst Healthcare	4	Leadership Ability	Numeracy	IELTS	Proficient
JSeeker112	JPosting20	Health Data Analyst	Statistics	Bachelor	Specific Enterprise	Data Analyst Healthcare	3	Data Analytics Mastery	Numeracy	CELPIP	Intermediate

Job Seeker	Apply To JPosting	Apply To BTM Job Title	Edu Field	Edu Level	Training1	Experience Field1	Exp Years	Technical Skills1	Soft Skill1	Lang Certificate Code	Lang Certificate Level
					Solutions Training Courses						
JSeeker113	JPosting20	Health Data Analyst	Computing And Information Science	Bachelor	Specific Enterprise Solutions Training Courses	Data Analyst Healthcare	3	Data Analytics Mastery	Numeracy	CELPIP	Intermediate
JSeeker114	JPosting21	Process Improvement Analyst	Business Administration	Bachelor	Six Sigma Training Green Lack Master Black Belt	Project Management	6	Conducting In Depth Analysis	Numeracy	TEF Canada	Intermediate
JSeeker115	JPosting21	Process Improvement Analyst	Business Technology Management	Masters	Process Improvement Training	Project Management	4	Leadership Ability	Continuous Learning	CELPIP	Proficient
JSeeker116	JPosting21	Process Improvement Analyst	Computer Science	Bachelor	Six Sigma Training Green Lack Master Black Belt	Project Management	6	Conducting In Depth Analysis	Numeracy	TEF Canada	Intermediate
JSeeker117	JPosting21	Process Improvement Analyst	Business Administration	Bachelor	Six Sigma Training Green Lack Master Black Belt	Project Management	6	Conducting In Depth Analysis	Numeracy	TEF Canada	Intermediate
JSeeker118	JPosting21	Process Improvement Analyst	Computer Science	Diploma	Six Sigma Training Green Lack Master Black Belt	Risk Management	5	Conducting In Depth Analysis	Reading Text	Nil	Proficient
JSeeker119	JPosting21	Process Improvement Analyst	Business Administration	Bachelor	Six Sigma Training Green Lack Master Black Belt	Project Management	6	Conducting In Depth Analysis	Numeracy	TEF Canada	Intermediate
JSeeker120	JPosting21	Process Improvement Analyst	Management	Bachelor	Six Sigma Training Green Lack Master Black Belt	Project Management	3	Conducting In Depth Analysis	Numeracy	TOEIC	Intermediate
JSeeker121	JPosting21	Process Improvement Analyst	Computer Science	Bachelor	Six Sigma Training Green Lack Master Black Belt	Project Management	6	Conducting In Depth Analysis	Numeracy	TEF Canada	Intermediate
JSeeker122	JPosting21	Process Improvement Analyst	Information Technology	Masters	Industry Courses And Programs	IT Governance Processes	8	Conducting In Depth Analysis	Writing Skills	IELTS	Proficient
JSeeker123	JPosting21	Process Improvement Analyst	Business Administration	Bachelor	Six Sigma Training Green Lack Master Black Belt	Project Management	6	Conducting In Depth Analysis	Numeracy	TEF Canada	Intermediate
JSeeker124	JPosting22	Data Scientist Junior Data Science Analytics	Computing	Bachelor	Professional Certifications PMP	Junior Data Scientist	1	Analytical	Numeracy	IELTS	Intermediate
JSeeker125	JPosting22	Data Scientist Junior Data Science Analytics	Business	Bachelor	On The Job Training	Junior Data Scientist	2	Data Analytics Mastery	Numeracy	TCF Canada	Intermediate
JSeeker126	JPosting22	Data Scientist Junior Data Science Analytics	Computing	Bachelor	On The Job Training	Junior Data Scientist	2	Data Analytics Mastery	Numeracy	TCF Canada	Intermediate
JSeeker127	JPosting22	Data Scientist Junior Data Science Analytics	Information Technology	Bachelor	Specific Enterprise Solutions Training Courses	Project Management	4	Data Analytics Mastery	Problem Solving	CLB	Proficient
JSeeker128	JPosting22	Data Scientist Junior Data Science Analytics	Business	Bachelor	On The Job Training	Junior Data Scientist	2	Data Analytics Mastery	Numeracy	TCF Canada	Intermediate
JSeeker129	JPosting23	Product Innovation Specialist	Computer Science	Diploma	Process Improvement Training	Identifying Customer Needs And Market Trends	4	Customer Service Orientation	Self Starter	TEF Canada	Proficient
JSeeker130	JPosting23	Product Innovation Specialist	Commerce	Bachelor	Industry Courses And Programs	Technical Support	3	Analytical	Self Starter	IELTS	Intermediate
JSeeker131	JPosting23	Product Innovation Specialist	Commerce	Diploma	Process Improvement Training	Identifying Customer Needs And Market Trends	4	Customer Service Orientation	Self Starter	TEF Canada	Proficient
JSeeker132	JPosting23	Product Innovation Specialist	Business	Bachelor	On The Job Training	Project Management	5	Customer Service Orientation	Decision Making	CELPIP	Proficient

Job Seeker	Apply To JPosting	Apply To BTM Job Title	Edu Field	Edu Level	Training1	Experience Field1	Exp Years	Technical Skills1	Soft Skill1	Lang Certificate Code	Lang Certificate Level
JSeeker133	JPosting23	Product Innovation Specialist	Computer Science	Diploma	Process Improvement Training	Identifying Customer Needs And Market Trends	4	Customer Service Orientation	Self Starter	TEF Canada	Proficient
JSeeker134	JPosting23	Product Innovation Specialist	Computing	Bachelor	Professional Certifications PMP	Identifying Customer Needs And Market Trends	4	Conducting In Depth Analysis	Continuous Learning	TOEIC	Intermediate
JSeeker135	JPosting23	Product Innovation Specialist	Computer Science	Diploma	Process Improvement Training	Identifying Customer Needs And Market Trends	4	Customer Service Orientation	Self Starter	TEF Canada	Proficient
JSeeker136	JPosting24	Financial Services Cyber Security Specialist	Business Technology Management	Masters	Industry Courses And Programs	Cyber Security Financial IT	2	Problem And Opportunity Proficiency	Document Use	CLB	Intermediate
JSeeker137	JPosting24	Financial Services Cyber Security Specialist	Business Technology Management	Bachelor	Platform Vendor Provided Certifications	Cyber Security Financial IT	3	Problem And Opportunity Proficiency	Numeracy	IELTS	Proficient
JSeeker138	JPosting24	Financial Services Cyber Security Specialist	Computer Science	Diploma	Platform Vendor Provided Certifications	IT Governance Processes	5	Data Analytics Mastery	Problem Solving	TCF Canada	Intermediate
JSeeker139	JPosting24	Financial Services Cyber Security Specialist	Business Technology Management	Bachelor	Platform Vendor Provided Certifications	Cyber Security Financial IT	3	Problem And Opportunity Proficiency	Numeracy	IELTS	Proficient
JSeeker140	JPosting24	Financial Services Cyber Security Specialist	Computer Science	Bachelor	Platform Vendor Provided Certifications	Cyber Security Financial IT	3	Problem And Opportunity Proficiency	Numeracy	IELTS	Proficient
JSeeker141	JPosting25	Health Business Analyst	Computing	Bachelor	On The Job Training	Process Improvement	4	Big Data Ecosystems	Document Use	TOEIC	Proficient
JSeeker142	JPosting25	Health Business Analyst	Business	Diploma	On The Job Training	Business Analyst Healthcare	5	Comprehensive Business Analysis	Document Use	CLB	Intermediate
JSeeker143	JPosting25	Health Business Analyst	Computing	Diploma	On The Job Training	Business Analyst Healthcare	5	Comprehensive Business Analysis	Document Use	CLB	Intermediate
JSeeker144	JPosting25	Health Business Analyst	Computing And Information Science	Bachelor	Project Management Training Courses	Risk Management	3	Comprehensive Business Analysis	Thinking Skills	CELPIP	Intermediate
JSeeker145	JPosting25	Health Business Analyst	Business	Diploma	On The Job Training	Business Analyst Healthcare	5	Comprehensive Business Analysis	Document Use	CLB	Intermediate
JSeeker146	JPosting25	Health Business Analyst	Computing	Masters	Platform Vendor Provided Certifications	Data Analysis	6	Comprehensive Business Analysis	Problem Solving	TEF Canada	Proficient
JSeeker147	JPosting25	Health Business Analyst	Business	Bachelor	On The Job Training	Business Analyst Healthcare	5	Comprehensive Business Analysis	Document Use	CLB	Intermediate
JSeeker148	JPosting25	Health Business Analyst	Computer Science	Diploma	On The Job Training	Business Analyst Healthcare	5	Comprehensive Business Analysis	Document Use	IELTS	Proficient
JSeeker149	JPosting26	Health Enterprise Solutions Manager	Computing	Diploma	On The Job Training	Enterprise Solutions Management Healthcare	10	Program Management	Leadership Skills	CELPIP	Proficient
JSeeker150	JPosting26	Health Enterprise Solutions Manager	Computing	Masters	Process Improvement Training	Enterprise Solutions Management Healthcare	11	Program Management	Stress Tolerant	TCF Canada	Proficient
JSeeker151	JPosting26	Health Enterprise Solutions Manager	Business	Diploma	On The Job Training	Enterprise Solutions Management Healthcare	10	Program Management	Leadership Skills	CELPIP	Proficient
JSeeker152	JPosting26	Health Enterprise Solutions Manager	Computer Science	Masters	On The Job Training	Technical Support	8	Big Data Ecosystems	Leadership Skills	TOEIC	Intermediate
JSeeker153	JPosting26	Health Enterprise Solutions Manager	Computing	Diploma	On The Job Training	Enterprise Solutions Management Healthcare	10	Program Management	Leadership Skills	CELPIP	Proficient
JSeeker154	JPosting27	Health Systems Analyst	Computing And Information Science	Bachelor	Professional Certifications In Systems Analys	Systems Analyst Healthcare	4	System Development Mastery	Collaboration	TOEIC	Intermediate
JSeeker155	JPosting27	Health Systems Analyst	Information Technology	Bachelor	Industry Courses And Programs	IT Governance Processes	3	Business Process Improvement	Finding Information	TEF Canada	Proficient
JSeeker156	JPosting27	Health Systems Analyst	Business	Bachelor	Professional Certifications In Systems Analys	Systems Analyst Healthcare	4	System Development Mastery	Collaboration	TOEIC	Intermediate

Job Seeker	Apply To JPosting	Apply To BTM Job Title	Edu Field	Edu Level	Training1	Experience Field1	Exp Years	Technical Skills1	Soft Skill1	Lang Certificate Code	Lang Certificate Level
JSeeker157	JPosting27	Health Systems Analyst	Business Technology Management	Masters	On The Job Training	Business Technology Experience	2	System Development Mastery	Collaboration	IELTS	Intermediate
JSeeker158	JPosting27	Health Systems Analyst	Computing And Information Science	Bachelor	Professional Certifications In Systems Analys	Systems Analyst Healthcare	4	System Development Mastery	Collaboration	TOEIC	Intermediate
JSeeker159	JPosting27	Health Systems Analyst	Business	Bachelor	Professional Certifications ACP	Systems Analyst Healthcare	6	Big Data Ecosystems	Leadership Skills	CELPIP	Proficient
JSeeker160	JPosting27	Health Systems Analyst	Computing And Information Science	Bachelor	Professional Certifications In Systems Analys	Systems Analyst Healthcare	4	System Development Mastery	Collaboration	TOEIC	Intermediate

Appendix H

BTM Jobs Ontology Matching Results

Job Posting 1

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker 1	10	15	10	5	5	10	10	5	5
Job Seeker 2	5	15	10	0	5	10	5	2	2
Job Seeker 3	10	10	5	5	5	5	5	5	2
Job Seeker 4	5	10	5	5	5	5	5	2	5
Job Seeker 5	5	15	5	5	5	5	10	2	2
Job Seeker 6	5	10	10	5	5	10	5	2	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker 1	1.00	1.00	1.00	0.50	0.20	1.00	1.00	1.00	1.00
Job Seeker 2	0.50	1.00	1.00	0.00	0.20	1.00	0.50	0.40	0.40
Job Seeker 3	1.00	0.67	0.50	0.50	0.20	0.50	0.50	1.00	0.40
Job Seeker 4	0.50	0.67	0.50	0.50	0.20	0.50	0.50	0.40	1.00
Job Seeker 5	0.50	1.00	0.50	0.50	0.20	0.50	1.00	0.40	0.40
Job Seeker 6	0.50	0.67	1.00	0.50	0.20	1.00	0.50	0.40	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker 1	25.00	20.00	10.00	20.00	30.00	75.00
Job Seeker 2	20.00	15.00	7.50	8.00	15.50	50.50
Job Seeker 3	20.00	15.00	5.00	14.00	19.00	54.00
Job Seeker 4	15.00	15.00	5.00	14.00	19.00	49.00
Job Seeker 5	20.00	15.00	7.50	8.00	15.50	50.50
Job Seeker 6	15.00	20.00	7.50	14.00	21.50	56.50

Job Posting 2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker7	5	15	5	5	5	5	10	2	2
Job Seeker 8	10	5	10	0	5	5	0	5	0
Job Seeker9	10	15	10	10	5	10	10	5	5
Job Seeker10	5	10	5	10	20	5	5	2	5
Job Seeker11	10	15	5	0	5	5	0	2	0
Job Seeker12	10	15	10	10	5	10	10	5	5
Job Seeker13	5	15	0	0	0	5	0	2	2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker7	0.50	1.00	0.50	0.50	0.20	0.50	1.00	0.40	0.40
Job Seeker 8	1.00	0.33	1.00	0.00	0.20	0.50	0.00	1.00	0.00
Job Seeker9	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker10	0.50	0.67	0.50	1.00	0.80	0.50	0.50	0.40	1.00
Job Seeker11	1.00	1.00	0.50	0.00	0.20	0.50	0.00	0.40	0.00
Job Seeker12	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker13	0.50	1.00	0.00	0.00	0.00	0.50	0.00	0.40	0.40

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker7	20.00	15.00	15.00	4.00	19.00	54.00
Job Seeker 8	15.00	15.00	5.00	5.00	10.00	40.00
Job Seeker9	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker10	15.00	35.00	10.00	7.00	17.00	67.00
Job Seeker11	25.00	10.00	5.00	2.00	7.00	42.00
Job Seeker12	25.00	25.00	20.00	5.00	25.00	75.00
Job Seeker13	20.00	0.00	5.00	4.00	9.00	29.00

Job Posting 3

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker14	10	15	5	5	5	5	5	2	2
Job Seeker15	10	15	10	0	5	10	0	5	0
Job Seeker16	5	5	0	0	0	5	0	2	0
Job Seeker17	5	15	5	5	5	5	0	5	0
Job Seeker18	5	5	10	0	5	10	5	2	0
Job Seeker19	10	15	10	0	5	10	0	5	0

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker14	1.00	1.00	0.50	0.50	0.20	0.50	0.50	0.40	0.40
Job Seeker15	1.00	1.00	1.00	0.00	0.20	1.00	0.00	1.00	0.00
Job Seeker16	0.50	0.33	0.00	0.00	0.00	0.50	0.00	0.40	0.00
Job Seeker17	0.50	1.00	0.50	0.50	0.20	0.50	0.00	1.00	0.00
Job Seeker18	0.50	0.33	1.00	0.00	0.20	1.00	0.50	0.40	0.00
Job Seeker19	1.00	1.00	1.00	0.00	0.20	1.00	0.00	1.00	0.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker14	25.00	15.00	10.00	4.00	14.00	54.00
Job Seeker15	25.00	15.00	10.00	5.00	15.00	55.00
Job Seeker16	10.00	0.00	5.00	2.00	7.00	17.00
Job Seeker17	20.00	15.00	5.00	5.00	10.00	45.00
Job Seeker18	10.00	15.00	15.00	2.00	17.00	42.00
Job Seeker19	25.00	15.00	10.00	5.00	15.00	55.00

Job Posting 4

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker20	10	10	5	0	5	5	0	2	5
Job Seeker21	10	15	10	0	5	5	0	2	0
Job Seeker22	10	15	10	10	20	10	5	5	5
Job Seeker23	5	10	5	10	20	5	5	2	0

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker20	1.00	0.66	0.50	0.00	0.20	0.50	0.00	0.40	1.00
Job Seeker21	1.00	1.00	1.00	0.00	0.20	0.50	0.00	0.40	0.00
Job Seeker22	1.00	1.00	1.00	1.00	0.80	1.00	0.50	1.00	1.00
Job Seeker23	0.50	0.66	0.50	1.00	0.80	0.50	0.50	0.40	0.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker20	20.00	10.00	5.00	7.00	12.00	42.00
Job Seeker21	25.00	15.00	5.00	2.00	7.00	47.00
Job Seeker22	25.00	40.00	15.00	10.00	25.00	90.00
Job Seeker23	15.00	35.00	10.00	2.00	12.00	62.00

Job Posting 5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker24	10	5	10	0	5	5	0	2	0
Job Seeker25	10	15	10	10	5	10	0	5	0
Job Seeker26	5	15	5	0	5	5	0	2	0
Job Seeker27	5	5	10	0	5	5	0	2	0
Job Seeker28	10	15	10	10	5	10	0	5	0

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker24	1.00	0.33	1.00	0.00	0.20	0.50	0.00	0.40	0.00
Job Seeker25	1.00	1.00	1.00	1.00	0.20	1.00	0.00	1.00	0.00
Job Seeker26	0.50	1.00	0.50	0.00	0.20	0.50	0.00	0.40	0.00
Job Seeker27	0.50	0.33	1.00	0.00	0.20	0.50	0.00	0.40	0.00
Job Seeker28	1.00	1.00	1.00	1.00	0.20	1.00	0.00	1.00	0.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skillsl Score	Total Score
Job Seeker24	15.00	15.00	2.50	4.00	6.50	36.50
Job Seeker25	25.00	25.00	5.00	10.00	15.00	65.00
Job Seeker26	20.00	10.00	2.50	4.00	6.50	36.50
Job Seeker27	10.00	15.00	2.50	4.00	6.50	31.50
Job Seeker28	25.00	25.00	5.00	10.00	15.00	65.00

Job Posting 6

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker29	5	15	10	0	5	10	0	5	2
Job Seeker30	5	10	5	5	20	5	5	5	2
Job Seeker31	10	15	10	10	5	10	10	5	5
Job Seeker32	10	15	10	10	5	10	10	5	5
Job Seeker33	10	15	10	10	5	10	10	5	5
Job Seeker34	10	5	10	5	5	5	0	2	0
Job Seeker35	10	15	10	10	5	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker29	0.50	1.00	1.00	0.00	0.20	1.00	0.00	1.00	0.40
Job Seeker30	0.50	0.67	0.50	0.50	0.80	0.50	0.50	1.00	0.40
Job Seeker31	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker32	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker33	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker34	1.00	0.33	1.00	0.50	0.20	0.50	0.00	0.40	0.00
Job Seeker35	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker29	20.00	15.00	10.00	7.00	17.00	52.00
Job Seeker30	15.00	30.00	10.00	7.00	17.00	62.00
Job Seeker31	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker32	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker33	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker34	15.00	20.00	5.00	2.00	7.00	42.00
Job Seeker35	25.00	25.00	20.00	10.00	30.00	80.00

Job Posting 7

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker36	10	15	10	5	25	10	5	2	2
Job Seeker37	10	10	5	5	25	5	5	2	0
Job Seeker38	10	15	5	10	25	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker36	1.00	1.00	1.00	0.50	1.00	1.00	0.50	0.40	0.40
Job Seeker37	1.00	0.67	0.50	0.50	1.00	0.50	0.50	0.40	0.00
Job Seeker38	1.00	1.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker36	25.00	40.00	15.00	4.00	19.00	84.00
Job Seeker37	20.00	35.00	10.00	2.00	12.00	67.00
Job Seeker38	25.00	40.00	20.00	10.00	30.00	95.00

Job Posting 8

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker39	10	15	10	10	5	10	10	5	5
Job Seeker40	10	10	5	5	5	5	0	2	5
Job Seeker41	10	15	10	10	5	10	10	5	5
Job Seeker42	5	10	10	5	5	5	10	2	2
Job Seeker43	10	15	5	10	5	10	5	5	2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker39	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker40	1.00	0.67	0.50	0.50	0.20	0.50	0.00	0.40	1.00
Job Seeker41	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker42	0.50	0.67	1.00	0.50	0.20	0.50	1.00	0.40	0.40
Job Seeker43	1.00	1.00	0.50	1.00	0.20	1.00	0.50	1.00	0.40

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker39	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker40	20.00	15.00	5.00	7.00	12.00	47.00
Job Seeker41	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker42	15.00	20.00	15.00	4.00	19.00	54.00
Job Seeker43	25.00	20.00	15.00	7.00	22.00	67.00

Job Posting9

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker44	10	15	5	0	5	10	0	5	2
Job Seeker45	5	10	10	5	25	5	5	2	0
Job Seeker46	10	15	10	10	25	10	10	5	5
Job Seeker47	5	5	5	10	5	10	0	2	5
Job Seeker48	5	15	5	10	25	10	10	5	5
Job Seeker49	5	15	5	0	5	5	5	2	0
Job Seeker50	10	15	10	10	25	10	10	5	5
Job Seeker51	10	5	10	0	25	5	10	2	0
Job Seeker52	5	15	10	10	25	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker44	1.00	1.00	0.50	0.00	0.20	1.00	0.00	1.00	0.40
Job Seeker45	0.50	0.67	1.00	0.50	1.00	0.50	0.50	0.40	0.00
Job Seeker46	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Job Seeker47	0.50	0.33	0.50	1.00	0.20	1.00	0.00	0.40	1.00
Job Seeker48	0.50	1.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00
Job Seeker49	0.50	1.00	0.50	0.00	0.20	0.50	0.50	0.40	0.00
Job Seeker50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Job Seeker51	1.00	0.33	1.00	0.00	1.00	0.50	1.00	0.40	0.00
Job Seeker52	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker44	25.00	10.00	10.00	7.00	17.00	52.00
Job Seeker45	15.00	40.00	10.00	2.00	12.00	67.00
Job Seeker46	25.00	45.00	20.00	10.00	30.00	100.00
Job Seeker47	10.00	20.00	10.00	7.00	17.00	47.00
Job Seeker48	20.00	40.00	20.00	10.00	30.00	90.00
Job Seeker49	20.00	10.00	10.00	2.00	12.00	42.00
Job Seeker50	25.00	45.00	20.00	10.00	30.00	100.00
Job Seeker51	15.00	35.00	15.00	2.00	17.00	67.00
Job Seeker52	20.00	45.00	20.00	10.00	30.00	95.00

Job Posting 10

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker53	10	15	10	0	5	10	10	5	5
Job Seeker54	10	5	5	0	5	5	5	2	5
Job Seeker55	10	15	10	0	5	5	0	5	2
Job Seeker56	10	15	10	0	5	5	0	5	2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker53	1.00	1.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00
Job Seeker54	1.00	0.33	0.50	0.00	0.20	0.50	0.50	0.40	1.00
Job Seeker55	1.00	1.00	1.00	0.00	0.20	0.50	0.00	1.00	0.40
Job Seeker56	1.00	1.00	1.00	0.00	0.20	0.50	0.00	1.00	0.40

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker53	25.00	15.00	20.00	10.00	30.00	70.00
Job Seeker54	15.00	10.00	10.00	7.00	17.00	42.00
Job Seeker55	25.00	15.00	5.00	7.00	12.00	52.00
Job Seeker56	25.00	15.00	5.00	7.00	12.00	52.00

Job Posting 11

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker57	10	10	5	0	20	10	0	2	5
Job Seeker58	10	15	5	10	20	10	10	5	5
Job Seeker59	10	10	5	5	25	10	0	5	2
Job Seeker60	10	15	5	10	20	10	10	5	5
Job Seeker61	10	15	5	10	20	10	10	5	5
Job Seeker62	5	15	5	0	5	5	5	2	0
Job Seeker63	10	15	5	10	20	10	10	5	5
Job Seeker64	5	10	5	10	5	10	0	2	0
Job Seeker65	10	10	5	10	25	5	5	5	2
Job Seeker66	10	15	5	10	20	10	10	5	5
Job Seeker67	10	15	5	10	20	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker57	1.00	0.67	0.50	0.00	0.80	1.00	0.00	0.40	1.00
Job Seeker58	1.00	1.00	0.50	1.00	0.80	1.00	1.00	1.00	1.00
Job Seeker59	1.00	0.67	0.50	0.50	1.00	1.00	0.00	1.00	0.40
Job Seeker60	1.00	1.00	0.50	1.00	0.80	1.00	1.00	1.00	1.00
Job Seeker61	1.00	1.00	0.50	1.00	0.80	1.00	1.00	1.00	1.00
Job Seeker62	0.50	1.00	0.50	0.00	0.20	0.50	0.50	0.40	0.00
Job Seeker63	1.00	1.00	0.50	1.00	0.80	1.00	1.00	1.00	1.00
Job Seeker64	0.50	0.67	0.50	1.00	0.20	1.00	0.00	0.40	0.00
Job Seeker65	1.00	0.67	0.50	1.00	1.00	0.50	0.50	1.00	0.40
Job Seeker66	1.00	1.00	0.50	1.00	0.80	1.00	1.00	1.00	1.00
Job Seeker67	1.00	1.00	0.50	1.00	0.80	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker57	20.00	25.00	10.00	7.00	17.00	62.00
Job Seeker58	25.00	35.00	20.00	10.00	30.00	90.00
Job Seeker59	20.00	35.00	10.00	7.00	17.00	72.00
Job Seeker60	25.00	35.00	20.00	10.00	30.00	90.00
Job Seeker61	25.00	35.00	20.00	10.00	30.00	90.00
Job Seeker62	20.00	10.00	10.00	2.00	12.00	42.00
Job Seeker63	25.00	35.00	20.00	10.00	30.00	90.00
Job Seeker64	15.00	20.00	10.00	2.00	12.00	47.00
Job Seeker65	20.00	40.00	10.00	7.00	17.00	77.00
Job Seeker66	25.00	35.00	20.00	10.00	30.00	90.00
Job Seeker67	25.00	35.00	20.00	10.00	30.00	90.00

Job Posting 12

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker68	10	15	10	10	20	10	10	5	5
Job Seeker69	10	10	10	0	5	5	5	5	2
Job Seeker70	10	15	10	10	20	10	10	5	5
Job Seeker71	10	10	5	5	25	10	10	5	2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker68	1.00	1.00	1.00	1.00	0.80	1.00	1.00	1.00	1.00
Job Seeker69	1.00	0.67	1.00	0.00	0.20	0.50	0.50	1.00	0.40
Job Seeker70	1.00	1.00	1.00	1.00	0.80	1.00	1.00	1.00	1.00
Job Seeker71	1.00	0.67	0.50	0.50	1.00	1.00	1.00	1.00	0.40

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker68	25.00	40.00	20.00	10.00	30.00	95.00
Job Seeker69	20.00	15.00	10.00	7.00	17.00	52.00
Job Seeker70	25.00	40.00	20.00	10.00	30.00	95.00
Job Seeker71	20.00	35.00	20.00	7.00	27.00	82.00

Job Posting 13

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker72	10	15	10	0	5	10	10	5	5
Job Seeker73	10	5	10	0	5	10	0	5	2
Job Seeker74	10	15	10	0	5	10	10	5	5
Job Seeker75	5	15	5	0	5	5	5	2	2
Job Seeker76	10	5	0	0	0	10	0	2	5
Job Seeker77	10	15	10	0	5	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker72	1.00	1.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00
Job Seeker73	1.00	0.33	1.00	0.00	0.20	1.00	0.00	1.00	0.40
Job Seeker74	1.00	1.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00
Job Seeker75	0.50	1.00	0.50	0.00	0.20	0.50	0.50	0.40	0.40
Job Seeker76	1.00	0.33	0.00	0.00	0.00	1.00	0.00	0.40	1.00
Job Seeker77	1.00	1.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker72	25.00	15.00	20.00	10.00	30.00	70.00
Job Seeker73	15.00	15.00	10.00	7.00	17.00	47.00
Job Seeker74	25.00	15.00	20.00	10.00	30.00	70.00
Job Seeker75	20.00	10.00	10.00	4.00	14.00	44.00
Job Seeker76	15.00	0.00	10.00	7.00	17.00	32.00
Job Seeker77	25.00	15.00	20.00	10.00	30.00	70.00

Job Posting 14

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker78	10	5	10	5	25	10	5	5	2
Job Seeker79	10	15	10	10	25	10	10	5	5
Job Seeker80	5	15	10	0	25	5	5	2	2
Job Seeker81	10	15	10	10	25	10	10	5	5
Job Seeker82	10	15	10	10	25	10	10	5	5
Job Seeker83	5	10	10	5	25	10	5	5	2
Job Seeker84	10	15	10	10	25	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker78	1.00	0.33	1.00	0.50	1.00	1.00	0.50	1.00	0.40
Job Seeker79	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Job Seeker80	0.50	1.00	1.00	0.00	1.00	0.50	0.50	0.40	0.40
Job Seeker81	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Job Seeker82	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Job Seeker83	0.50	0.67	1.00	0.50	1.00	1.00	0.50	1.00	0.40
Job Seeker84	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker78	15.00	40.00	7.50	14.00	21.50	76.50
Job Seeker79	25.00	45.00	10.00	20.00	30.00	100.00
Job Seeker80	20.00	35.00	5.00	8.00	13.00	68.00
Job Seeker81	25.00	45.00	10.00	20.00	30.00	100.00
Job Seeker82	25.00	45.00	10.00	20.00	30.00	100.00
Job Seeker83	15.00	40.00	7.50	14.00	21.50	76.50
Job Seeker84	25.00	45.00	10.00	20.00	30.00	100.00

Job Posting 15

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker85	10	10	10	5	25	10	5	5	2
Job Seeker86	10	15	10	10	5	5	10	5	5
Job Seeker87	10	10	10	5	5	5	5	2	5
Job Seeker88	10	15	10	10	5	5	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker85	1.00	0.67	1.00	0.50	1.00	1.00	0.50	1.00	0.40
Job Seeker86	1.00	1.00	1.00	1.00	0.20	0.50	1.00	1.00	1.00
Job Seeker87	1.00	0.67	1.00	0.50	0.20	0.50	0.50	0.40	1.00
Job Seeker88	1.00	1.00	1.00	1.00	0.20	0.50	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker85	20.00	40.00	7.50	14.00	21.50	81.50
Job Seeker86	25.00	25.00	7.50	20.00	27.50	77.50
Job Seeker87	20.00	20.00	5.00	14.00	19.00	59.00
Job Seeker88	25.00	25.00	7.50	20.00	27.50	77.50

Job Posting 16

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker89	10	5	10	10	5	5	5	5	2
Job Seeker90	5	15	10	10	5	10	5	5	5
Job Seeker91	10	15	10	10	5	10	5	5	2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker89	1.00	0.33	1.00	1.00	0.20	0.50	0.50	1.00	0.40
Job Seeker90	0.50	1.00	1.00	1.00	0.20	1.00	0.50	1.00	1.00
Job Seeker91	1.00	1.00	1.00	1.00	0.20	1.00	0.50	1.00	0.40

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker89	15.00	25.00	10.00	7.00	17.00	57.00
Job Seeker90	20.00	25.00	15.00	10.00	25.00	70.00
Job Seeker91	25.00	25.00	15.00	7.00	22.00	72.00

Job Posting 17

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker92	10	10	10	10	5	10	10	5	5
Job Seeker93	10	10	10	5	5	5	10	5	2
Job Seeker94	10	15	10	10	5	10	10	5	5
Job Seeker95	5	15	10	5	5	10	5	2	5
Job Seeker96	10	15	10	10	5	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker92	1.00	0.67	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker93	1.00	0.67	1.00	0.50	0.20	0.50	1.00	1.00	0.40
Job Seeker94	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker95	0.50	1.00	1.00	0.50	0.20	1.00	0.50	0.40	1.00
Job Seeker96	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker92	20.00	25.00	10.00	20.00	30.00	75.00
Job Seeker93	20.00	20.00	7.50	14.00	21.50	61.50
Job Seeker94	25.00	25.00	10.00	20.00	30.00	80.00
Job Seeker95	20.00	20.00	7.50	14.00	21.50	61.50
Job Seeker96	25.00	25.00	10.00	20.00	30.00	80.00

Job Posting 18

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker97	10	10	5	10	5	10	5	2	2
Job Seeker98	10	15	10	10	5	10	10	5	5
Job Seeker99	10	15	10	10	5	10	10	5	5
Job Seeker100	10	10	10	5	5	5	5	2	5
Job Seeker101	10	15	10	10	5	10	10	5	5
Job Seeker102	5	10	10	5	5	5	10	5	2
Job Seeker103	10	15	10	10	5	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker97	1.00	0.67	0.50	1.00	0.20	1.00	0.50	0.40	0.40
Job Seeker98	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker99	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker100	1.00	0.67	1.00	0.50	0.20	0.50	0.50	0.40	1.00
Job Seeker101	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker102	0.50	0.67	1.00	0.50	0.20	0.50	1.00	1.00	0.40
Job Seeker103	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker97	20.00	20.00	7.50	8.00	15.50	55.50
Job Seeker98	25.00	25.00	10.00	20.00	30.00	80.00
Job Seeker99	25.00	25.00	10.00	20.00	30.00	80.00
Job Seeker100	20.00	20.00	5.00	14.00	19.00	59.00
Job Seeker101	25.00	25.00	10.00	20.00	30.00	80.00
Job Seeker102	15.00	20.00	7.50	14.00	21.50	56.50
Job Seeker103	25.00	25.00	10.00	20.00	30.00	80.00

Job Posting 19

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker104	10	15	5	10	5	5	5	2	5
Job Seeker105	10	15	10	10	25	10	5	5	5
Job Seeker106	5	5	10	5	25	10	5	5	2
Job Seeker107	10	15	10	10	25	10	5	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker104	1.00	1.00	0.50	1.00	0.20	0.50	0.50	0.40	1.00
Job Seeker105	1.00	1.00	1.00	1.00	1.00	1.00	0.50	1.00	1.00
Job Seeker106	0.50	0.33	1.00	0.50	1.00	1.00	0.50	1.00	0.40
Job Seeker107	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker104	25.00	20.00	5.00	14.00	19.00	64.00
Job Seeker105	25.00	45.00	7.50	20.00	27.50	97.50
Job Seeker106	10.00	40.00	7.50	14.00	21.50	71.50
Job Seeker107	25.00	45.00	7.50	20.00	27.50	97.50

Job Posting 20

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker108	10	15	10	0	20	10	10	5	5
Job Seeker109	10	10	0	0	0	5	5	2	5
Job Seeker110	10	15	10	0	20	10	10	5	5
Job Seeker111	5	5	10	5	25	5	10	5	2
Job Seeker112	10	15	10	0	20	10	10	5	5
Job Seeker113	10	15	10	0	20	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker108	1.00	1.00	1.00	0.00	0.80	1.00	1.00	1.00	1.00
Job Seeker109	1.00	0.67	0.00	0.00	0.00	0.50	0.50	0.40	1.00
Job Seeker110	1.00	1.00	1.00	0.00	0.80	1.00	1.00	1.00	1.00
Job Seeker111	0.50	0.33	1.00	0.50	1.00	0.50	1.00	1.00	0.40
Job Seeker112	1.00	1.00	1.00	0.00	0.80	1.00	1.00	1.00	1.00
Job Seeker113	1.00	1.00	1.00	0.00	0.80	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker108	25.00	30.00	20.00	10.00	30.00	85.00
Job Seeker109	20.00	0.00	10.00	7.00	17.00	37.00
Job Seeker110	25.00	30.00	20.00	10.00	30.00	85.00
Job Seeker111	10.00	40.00	15.00	7.00	22.00	72.00
Job Seeker112	25.00	30.00	20.00	10.00	30.00	85.00
Job Seeker113	25.00	30.00	20.00	10.00	30.00	85.00

Job Posting 21

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker114	10	15	10	10	20	10	5	5	5
Job Seeker115	5	10	10	5	5	5	5	2	5
Job Seeker116	10	15	10	10	20	10	5	5	5
Job Seeker117	10	15	10	10	20	10	5	5	5
Job Seeker118	10	5	5	10	5	10	5	2	5
Job Seeker119	10	15	10	10	20	10	5	5	5
Job Seeker120	5	15	10	0	5	10	5	5	2
Job Seeker121	10	15	10	10	20	10	5	5	5
Job Seeker122	5	10	5	10	25	10	5	2	2
Job Seeker123	10	15	10	10	20	10	5	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker114	1.00	1.00	1.00	1.00	0.80	1.00	0.50	1.00	1.00
Job Seeker115	0.50	0.67	1.00	0.50	0.20	0.50	0.50	0.40	1.00
Job Seeker116	1.00	1.00	1.00	1.00	0.80	1.00	0.50	1.00	1.00
Job Seeker117	1.00	1.00	1.00	1.00	0.80	1.00	0.50	1.00	1.00
Job Seeker118	1.00	0.33	0.50	1.00	0.20	1.00	0.50	0.40	1.00
Job Seeker119	1.00	1.00	1.00	1.00	0.80	1.00	0.50	1.00	1.00
Job Seeker120	0.50	1.00	1.00	0.00	0.20	1.00	0.50	1.00	0.40
Job Seeker121	1.00	1.00	1.00	1.00	0.80	1.00	0.50	1.00	1.00
Job Seeker122	0.50	0.67	0.50	1.00	1.00	1.00	0.50	0.40	0.40
Job Seeker123	1.00	1.00	1.00	1.00	0.80	1.00	0.50	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skillsl Score	Total Score
Job Seeker114	25.00	40.00	15.00	10.00	25.00	90.00
Job Seeker115		20.00	10.00	7.00	17.00	37.00
Job Seeker116	25.00	40.00	15.00	10.00	25.00	90.00
Job Seeker117	25.00	40.00	15.00	10.00	25.00	90.00
Job Seeker118	15.00	20.00	15.00	7.00	22.00	57.00
Job Seeker119	25.00	40.00	15.00	10.00	25.00	90.00
Job Seeker121	25.00	40.00	15.00	10.00	25.00	90.00
Job Seeker122	15.00	40.00	15.00	4.00	19.00	74.00
Job Seeker123	25.00	40.00	15.00	10.00	25.00	90.00

Job Posting 22

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker124	10	15	10	0	5	5	10	5	2
Job Seeker125	10	15	10	10	5	10	10	5	5
Job Seeker126	10	15	10	10	5	10	10	5	2
Job Seeker127	5	15	5	10	5	10	5	2	5
Job Seeker128	10	15	10	10	5	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker124	1.00	1.00	1.00	0.00	0.20	0.50	1.00	1.00	0.40
Job Seeker125	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker126	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	0.40
Job Seeker127	0.50	1.00	0.50	1.00	0.20	1.00	0.50	0.40	1.00
Job Seeker128	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker124	25.00	15.00	15.00	7.00	22.00	62.00
Job Seeker125	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker126	25.00	25.00	20.00	7.00	27.00	77.00
Job Seeker127	20.00	20.00	15.00	7.00	22.00	62.00
Job Seeker128	25.00	25.00	20.00	10.00	30.00	80.00

Job Posting 23

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker129	10	15	10	10	5	10	10	5	5
Job Seeker130	10	10	10	0	5	5	10	5	2
Job Seeker131	10	15	10	10	5	10	10	5	5
Job Seeker132	5	10	5	5	5	10	5	2	5
Job Seeker133	10	15	10	10	5	10	10	5	5
Job Seeker134	5	10	10	5	5	5	5	2	2
Job Seeker135	10	15	10	10	5	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker129	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker130	1.00	0.67	1.00	0.00	0.20	0.50	1.00	1.00	0.40
Job Seeker131	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker132	0.50	0.67	0.50	0.50	0.20	1.00	0.50	1.00	1.00
Job Seeker133	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker134	0.50	0.67	1.00	0.50	0.20	0.50	0.50	0.40	0.40
Job Seeker135	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker129	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker130	20.00	15.00	15.00	7.00	22.00	57.00
Job Seeker131	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker132	15.00	15.00	15.00	7.00	22.00	52.00
Job Seeker133	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker134	15.00	20.00	10.00	4.00	14.00	49.00
Job Seeker135	25.00	25.00	20.00	10.00	30.00	80.00

Job Posting 24

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker136	10	10	10	5	5	10	5	2	5
Job Seeker137	10	15	10	10	5	10	10	5	5
Job Seeker138	10	5	5	10	5	5	10	2	2
Job Seeker140	10	15	10	10	5	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker136	1.00	0.67	1.00	0.50	0.20	1.00	0.50	0.40	1.00
Job Seeker137	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker138	1.00	0.33	0.50	1.00	0.20	0.50	1.00	0.40	0.40
Job Seeker139	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00
Job Seeker140	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker136	20.00	20.00	15.00	7.00	22.00	62.00
Job Seeker137	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker138	15.00	20.00	15.00	4.00	19.00	54.00
Job Seeker139	25.00	25.00	20.00	10.00	30.00	80.00
Job Seeker140	25.00	25.00	20.00	10.00	30.00	80.00

Job Posting 25

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker141	10	10	5	0	5	5	10	5	2
Job Seeker142	10	15	10	0	20	10	10	5	5
Job Seeker143	10	15	10	0	20	10	10	5	5
Job Seeker144	5	10	5	0	5	10	0	2	2
Job Seeker145	10	15	10	0	20	10	10	5	5
Job Seeker146	10	10	5	0	25	10	5	2	5
Job Seeker147	10	10	10	0	20	10	10	5	5
Job Seeker148	5	15	10	0	20	10	5	5	2

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker141	1.00	0.67	0.50	0.00	0.20	0.50	1.00	1.00	0.40
Job Seeker142	1.00	1.00	1.00	0.00	0.80	1.00	1.00	1.00	1.00
Job Seeker143	1.00	1.00	1.00	0.00	0.80	1.00	1.00	1.00	1.00
Job Seeker144	0.50	0.67	0.50	0.00	0.20	1.00	0.00	0.40	0.40
Job Seeker145	1.00	1.00	1.00	0.00	0.80	1.00	1.00	1.00	1.00
Job Seeker146	1.00	0.67	0.50	0.00	1.00	1.00	0.50	0.40	1.00
Job Seeker147	1.00	0.67	1.00	0.00	0.80	1.00	1.00	1.00	1.00
Job Seeker148	0.50	1.00	1.00	0.00	0.80	1.00	0.50	1.00	0.40

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker141	20.00	10.00	15.00	7.00	22.00	52.00
Job Seeker142	25.00	30.00	20.00	10.00	30.00	85.00
Job Seeker143	25.00	30.00	20.00	10.00	30.00	85.00
Job Seeker144	15.00	10.00	10.00	4.00	14.00	39.00
Job Seeker145	25.00	30.00	20.00	10.00	30.00	85.00
Job Seeker146	20.00	30.00	15.00	7.00	22.00	72.00
Job Seeker147	20.00	30.00	20.00	10.00	30.00	80.00
Job Seeker148	20.00	30.00	15.00	7.00	22.00	72.00

Job Posting 26

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker149	10	15	10	10	20	10	10	5	5
Job Seeker150	10	10	10	5	25	10	5	2	5
Job Seeker151	10	15	10	10	20	10	10	5	5
Job Seeker153	10	15	10	10	20	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker149	1.00	1.00	1.00	0.80	1.00	1.00	1.00	1.00	1.00
Job Seeker150	1.00	0.67	1.00	0.50	1.00	1.00	0.50	0.40	1.00
Job Seeker151	1.00	1.00	1.00	0.80	1.00	1.00	1.00	1.00	1.00
Job Seeker152	0.50	0.67	0.50	1.00	0.20	0.50	1.00	1.00	0.40
Job Seeker153	1.00	1.00	1.00	1.00	0.80	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker149	25.00	40.00	10.00	20.00	30.00	95.00
Job Seeker150	20.00	40.00	7.50	14.00	21.50	81.50
Job Seeker151	25.00	40.00	10.00	20.00	30.00	95.00
Job Seeker152	15.00	20.00	7.50	14.00	21.50	56.50
Job Seeker153	25.00	40.00	10.00	20.00	30.00	95.00

Job Posting 27

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker154	10	15	10	0	5	10	10	5	5
Job Seeker155	5	15	5	0	5	5	10	2	5
Job Seeker156	10	15	10	0	5	10	10	5	5
Job Seeker157	5	10	5	0	5	10	5	5	2
Job Seeker158	10	15	10	0	5	10	10	5	5
Job Seeker160	10	15	10	0	5	10	10	5	5

	Edu Field	Edu Level	Exp Field 1	Exp Field 2	Exp Years	Tech Skill 1	Tech Skill 2	Soft Skill 1	Soft Skill 2
Job Seeker154	1.00	1.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00
Job Seeker155	0.50	1.00	0.50	0.00	0.20	0.50	1.00	0.40	1.00
Job Seeker156	1.00	1.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00
Job Seeker157	0.50	0.67	0.50	0.00	0.20	1.00	0.50	1.00	0.40
Job Seeker158	1.00	1.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00
Job Seeker159	1.00	1.00	1.00	0.50	1.00	0.50	1.00	0.40	0.40
Job Seeker160	1.00	1.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00

	Edu Score	Exp Score	Tech Skills Score	Soft Skills Score	Skills Score	Total Score
Job Seeker154	25.00	15.00	20.00	10.00	30.00	70.00
Job Seeker155	20.00	10.00	15.00	7.00	22.00	52.00
Job Seeker156	25.00	15.00	20.00	10.00	30.00	70.00
Job Seeker157	15.00	10.00	15.00	7.00	22.00	47.00
Job Seeker158	25.00	15.00	20.00	10.00	30.00	70.00
Job Seeker159	25.00	40.00	15.00	4.00	19.00	84.00
Job Seeker160	25.00	15.00	20.00	10.00	30.00	70.00

END OF RESULTS