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6. Teaching Experience

6.2. On-Going Supervision of Graduate Theses and Projects

#	Student	Title	Activity	L	Prog.	Phase
1.	Kwan, Franck-Olivier	Risk management in IT projects: A descriptive research of the implementation of a risk management process based on semantic analysis; Dir.: Véronique Nabelsi	Thesis	3	DBA PM	Writing
2.	Harnois, Yanik	International Development Project Management: Impact of Transparency on Anti-Corruption Initiatives	Thesis	3	DBA PM	Writing
3.	Potvin, Joseph	An Internet of Rules	Thesis	3	DBA PM	Writing
4.	Murariu, Florica (Lily)	Business Technology Management (BTM) Executives and Digital Transformation Leadership	Thesis	3	DBA PM	Writing
5.	Quevedo, Arelis	Perceived risk contagion and project news: Market microstructure analysis comparing project-oriented and production-oriented industries; Co-Dir.: Salim Lahmiri	Thesis	3	DBA PM	Scolarity
6.	Cabot, Catherine	Career Anchors for Business Technology and Project Management Professionals	Thesis	3	DBA PM	Scolarity
7.	El Chababi, Maria	Toward an Integrated Capability Model for Artificial Intelligence and Analytics (AIA) Projects	Thesis	3	DBA PM	Scolarity
8.	Khosrojerdi, Farhad	An ontology-based decision-making framework modeling power efficiency for photovoltaic systems; Co-Dir.: Raul Valverde	Thesis	3	PhD STI	Writing
9.	Eloumri, Miloud	Integrating semantic reasoning in a multi-agent system in Erlang	Thesis	3	PhD STI	Writing
10.	Léger, Marc-André	Implementing business technology management with an ontology of cybersecurity professional skills; Co-Dir.: Raul Valverde	Thesis	3	PhD STI	Writing
11.	Torres, Beatriz	Business Technology Management Semantic Integration for Automated Project Team Composition; Co-Dir.: Raul Valverde	Thesis	3	PhD STI	Proposal
12.	Elgebli, Jamal	BTM Standards Integration within Talent Management Processes: An Ontology Engineering Approach	Thesis	3	PhD STI	Proposal
13.	Sidenko, Svetlana	Business Technology Management Standards Integration and Semantic Validation; Co-Dir.: Raul Valverde	Thesis	3	PhD STI	Exams
14.	Iyer, Shankar	Intelligent Systems and Ontology-Driven Engineering (ODE) for Migration, Integration, and Service of Heterogenous Enterprise Resource Planning (ERP) Platforms	Thesis	3	PhD STI	Exams

1. DBA PM Thesis – On-Going

Risk Management in IT Projects: Implementation of a Risk Management Process Based on Semantic Analysis

Kwan, Franck-Olivier

Dir.: Véronique Nabelsi; Co-Dir.: Stéphane Gagnon

Problem: This thesis demonstrates the feasibility of using semantic analysis as a risk management tool in IT projects. It assumes that if we can annotate all artifacts of a project, to indicate events related to various risks, we should be able in theory to use a semantic analysis tool to establish potential links between various events and risks, and thus identify the precursors to trace their occurrence. This kind of tool could therefore serve as a platform for preventative risk management in IT projects.

Theory: Our main contribution is the design, implementation-implement and validate a risk management process to exploit the artifacts of IT projects, treated with text analytics and detection of semantic structures, including outputs are integrated into an ontology or knowledge base related to the risks of such projects. It then uses the query and inference tools based on knowledge, so to recognize and classify the events as they are with or without the occurrence of potential risks. Finally, we interpret these results in comparison to a real risk audit, to determine the quality of the classification.

Data: Our experimental methodology is based on a real large-scale IT project carried out over a 7-year period in a large department. We analyze the artifacts related to the project documentation, Gantt schedules, system architecture documents and models, risk analysis reports and project audit reports. These artifacts are all integrated into the different features database servers (ie, SQL, NoSQL, RDF), allowing flexible representation while facilitating the indexing and querying via the standards of the semantic web.

Software: We use three groups of text analytics and semantic structures: (1) an ontology of risk that we develop based on subsets of the umbel and WordNet ontologies for describing the risks and main project components referred; (2) the ARDAKE software, or Adaptive Rules-Driven Architecture for Knowledge Extraction based on the platform Unstructured Information Management Architecture (UIMA), to formulate sets of annotation rules artifacts, and insert tags linked to different concepts our ontology; (3) software Protégé from Stanford University (USA) and ONTOP of Bozen-Bolzano University (Italy), for creating orders SPARQL to query all of our annotated artefacts, stored in different databases,

Methodology: Our validation process starts with the identification of ten high-risk events such as formally defined in a public audit of the referred project. For each risk, we develop annotation sets of rules in ARDAKE, to link the risk of events associated directly or indirectly, especially in a close period and precursors to the occurrence of the risk. These rules are executed to annotate all the artifacts in our databases, connecting each sentence, section, and relevant element to the events related to the risk. All artifacts are dated and have metadata about the author and the approval, we reconstruct the chain of events from artifacts and correlated to the hierarchy of the project team, which largely operates during the 7 years of implementation. Once completed annotations and re-enactments, we use software and Protected ONTOP to formulate SPARQL commands and question our annotated databases. The controls are a set of relevant precursors conditions for the occurrence of risk. Once executed, outputs must

report relevant risks initially identified, to maximize the accuracy of results, and the recall of all concepts related to risk.

Outcome: The results of our SPARQL controls are assessed by classification actions in machine learning and semantic distance measurements between the semantic structure of the identified events vs. semantic structure surrounding the risk covered by our validation. and attempting to classify the events present in the artifacts to be related or not to the risks identified in the audit report public. Performance measures 0.80 above (hypothetical) demonstrate that the tool can identify the precursor events to the occurrence of risks.

2. DBA PM Thesis – On-Going

International Development Project Management: Impact of Transparency on Anti-Corruption Initiatives

Harnois, Yanik

Dir.: Stéphane Gagnon

Context: International development project management presents many challenges that remain to be overcome, especially in the design practices of international aid projects. Year after year, statistics show the persistently low effectiveness of international development projects over the past thirty years. This remains so, even though development aid agencies have implemented the most modern project and program management methods.

Problem: Corruption at various levels and in various countries throughout the development aid value chain has often been cited as one of the main factors in this situation.

Theory: Our study attempts to bring a new perspective on the fight against corruption from the particular angle of the cultural, political, and institutional dimensions contained in the processes and methods of project management, which can prevent the objectives of projects from being achieved fully.

Contributions: We make contributions through three scientific articles:

- First, a review of the literature on corruption is offered, titled: ***Corruption and International Development: A Review of Project Management Challenges***.
- Second, a summary article on the historical context of development aid, and a critical analysis of management practices by project and by program, entitled: ***Governance of international development aid: Impacts of management by project and by program***.
- Third, an empirical article using the grounded theory methodology, based on expert interviews with 30 respondents, and summarizing the factors related to project management methods to support the fight against corruption, entitled: ***Anti-corruption Corruption and Project Management in International Development***.

An Internet of Rules

Potvin, Joseph

Dir.: Stéphane Gagnon

Context: This thesis seeks to contribute to the discipline of Project Management (PM) within the holistic framework that is “project ecology”. This “level of analysis” for theory building is defined by Austrian economic geographer Gernot Grabher as “the interface between projects and the organizations, communities, and networks in and through which projects operate” (Grabher, 2004).

Objectives: We address an often-overlooked issue in the PM literature, namely the challenges of ensuring consistency, reliability, and efficiency of rule-based decision-making throughout project value-chains. In addition to contributing to the study of rule-based PM, we also contribute an innovative technological platform, “An Internet of Rules”, and demonstrate its value for PM.

Problem: As a key factor distinguishing “organizing by projects” from routine operations, project teams are exposed to much more variability and uncertainty, and must take into account a greater variety and more frequently changing set of rules expressed in contracts, agreements, legislation, regulations, case law, advisories, directives, standards, manuals, protocols, principles, guidelines and informal conventions. Some rules must be complied with fully, some on a ‘best effort’ basis, and others are optional. Rules get updated from time to time, but on no schedule. Each organization exists within a municipal, regional, and national jurisdiction, all which issue and enforce their own rules. Various bilateral and multilateral agreements may be in force. The contracts, logistics and entities that every organization is involved with commonly from, or they span, other jurisdictions with different rules. Hence, the challenges of rule-based decision making, within PM and project ecology, can create unforeseen risk factors that may emerge through “self-organization”, as defined in the 2nd law of thermodynamics as applied in Complexity Theory.

Question: As evidence of this phenomenon abound, we focused our thesis on the next step in theory building, namely to accurately analyze where, operationally and technologically, the PM discipline may help to develop new standards to control and overcome these risk factors. Our research question is: How do project managers discover and obtain practical knowledge of all the institutional rules that are ‘in effect’ and directly ‘applicable’ to their circumstances, at any given time?

Theory: Building upon Agency Theory, and modelling project managers as agents seeking decision empowerment within a network of agents, we propose to automate project-wide and inter-project rule-based decision making by bridging the gap between rule makers and rule takers. Focusing on the “actionable” facets of agency, namely the criteria by which rule-based decision making can be implemented, we design a method for any project manager to discover and obtain all third party rules that are in effect and applicable to their decisions and interactions. A manager may or may not be aware of certain rules but would prefer to be notified about them. And the issuers of the rules may or may not know about certain managers but prefer to have a practical way of communicating with them. It is assumed that managers would tolerate some risk of exposing limited data about their identity and context to discover what rules are in effect and applicable to their current activity or decision.

Methodology: In pursuit of an empirical demonstration of this theoretical model, we carried out an Action Design Research (ADR) methodology, putting forward the business rationale, conceptual foundations, operational specifications, and working software to extend the Internet in a manner that will enable any project manager to easily disseminate, discover, and obtain algorithms which implement any class of rules that are in effect and that are applicable to their particular identity and circumstances.

Contributions: This doctoral dissertation is structured as a compendium of four academic papers.

- The first paper is theoretical, and distinguishes rules from algorithms, and explains both about Agency Theory. An algorithm is an extension of human agency, problems can arise when algorithm managers usurp agency from operations managers. The paper concludes with human-centered automation policies and principles for project management.
- The second paper positions our epistemological and methodological stance in ADR, focused on solving PM challenges with a meso-level network platform innovation. It explains the comprehensive micro-meso-macro "project ecology" perspective, discusses the challenges of theory building, and outlines a suitable design research methodology. It explains "engaged scholarship" with industry and tests for feasibility, generalization, and utility.
- The third paper explains the first empirical results, mostly an operational model of rule based PM. It relies on insights from Agency Theory and Information Theory to model practical management communication between rule-makers and rule-takers. It then presents a conceptual basis of measuring, costing and valuing information and uncertainty, and explains the approach taken in this design research to reducing the cost of rules discovery and transmission.
- The fourth paper presents the second empirical contribution, mostly technical implementation, outlining the rationale and design summary for software that implements the ideas explained in the accompanying papers.

Outcome: The implications for practice of our research are numerous. Among them, the proposed "Internet of Rules" will enable ubiquitous standards-based automation of rule-based PM decision-making. It is likely to ignite a new paradigm generating feedback effects on pre-digital PM practice.

4. DBA PM Thesis – On-Going

Business Technology Management (BTM) Executives and Digital Transformation Leadership

Murariu, Florica (Lily)

Dir.: Stéphane Gagnon

Context: Business Technology Management (BTM) is an emerging profession dedicated to leading the Digital Transformation of organizations and industries. Given their evolving roles and competency profile, we study how executives address the tasks of mobilizing peers, employees, resources, technologies, and partners in leveraging IT for innovative projects.

Problem: We focus on the public sector given its distinct set of constraints and the urgency of improving digital project performance and governance. Digital transformation and innovation are high priorities as governments try to improve service quality while reducing budgets, including information technology (IT) capital and operating expenditures. In this context, Chief Information Officers (CIOs), and their new counterpart Chief Digital Officers (CDOs), are challenged to find cheaper and yet more effective solutions to help their organization become lean and agile, while building upon prior enterprise-scale IT projects.

Theory: Our theoretical model builds upon Organizational Project Management (OPM) research to enrich BTM with a new competency model for executives.

Methodology: Using a comparative case study methodology, we analyze the evolving digital transformation project leadership approaches of 10 large public sector organizations. Sampling opportunistically within the same government makes our study more coherent within a single digital policy context. We carry interviews with CIOs and CDOs at 2 periods 4-years apart (2016 and 2020) and identify the lineage of the more stable competencies linked to digital project success at the senior executive level.

Outcome: Our proposed hypotheses integrate a loosely structured dynamic model with a more structured causal model. We close the proposal with a timetable to carry out the second phase of interviews and analysis.

5. DBA PM Thesis – On-Going

Perceived Risk Contagion and Project News: Market Microstructure Analysis Comparing Project-Oriented and Production-Oriented Industries

Quevedo, Arelis

Dir.: Stéphane Gagnon; Co-Dir.: Salim Lahmiri

Context: Project-related news have an impact on the market value. There is contagion of the perceived risk to securities of competing companies, or within the value chain, when news has significant change in the values of the securities jointly. Their effective detection requires simultaneous analysis of market risk and microstructure, especially the balance between demand and supply quotation orders.

Problem: We propose to analyze the financial market response to financial news, and the application of advanced Machine Learning techniques to financial market event pattern detection. The research objectives are to detect financial market events and monitor the risk contagion, using among network centrality metrics, among other techniques.

Data: We analyze 127 stocks of the S&P500, half divided between project-oriented (IT) and production-oriented (consumer products) industries. We focus on the software and computer segments of the Information Technology (IT) industry, compared to consumer and durable goods sectors. The proposed dataset consists of the exhaustive compilation of Bloomberg intraday data and Dow Jones Factiva news.

Methodology: We to apply sequential pattern recognition techniques in both news text and market data. To integrate Machine Learning in Finance, we would apply Dynamic Bayesian Networks (DBN) along with other sequential algorithms. It is used in a variety of fields such as medical informatics, engineering risk analysis, and activity recognition. We compute centrality statistics on the volatility and correlation networks among the companies. It will allow us to describe the Market Microstructure metrics in an intraday mode, detecting events and their impact on price movements.

Outcome: We hope this doctoral thesis will bring both theoretical advancements in DBN applications for complex network analysis, and applied contributions in computational finance applied to project announcement strategies.

Career Anchors for Business Technology and Project Management Professionals

Cabot, Catherine

Dir.: Stéphane Gagnon

Context: Business Technology Management (BTM) and Project Management (PM) are two rapidly emerging trans-disciplinary research areas and professional disciplines. Their intersection allows to unite Management Information Systems (MIS), Information Technology Management (ITM), and IT PM within a integrated framework entitled BTM. It seeks to provide guidance for the strategic use of technology and leading digital projects in organizations of all types. Each BTM specialization has well-established international associations, with certification levels supported by proven frameworks uniting best practices. These include Business Analysts, IT Services Management, IT Governance, IT Project Management, among 20+ specializations covered by the BTM Body of Knowledge (BOK) in development.

Problem: BTM professionals are submitted to increasingly complex career choices, with factors that impact their progression primarily driven by technology evolution, learning pace, and industry dynamics. Schools must adjust curricula for IS/IT and BTM to ensure employability of students in new markets, requiring more systematic career literacy programs. As well, with more diverse specializations and certifications required for salary progression, professionals are greatly constrained by competition, yet it is still unclear to what extent multiple certifications help them move along their careers, and what mix is best within an investment model of BTM jobs. There is also a shift away from traditional career progression (e.g., moving through Business Analysis, Project Management, and IT Services Management), which implied loyalty and promotion through ranks of a typical corporate IT division, toward diverse assignments with IT and business units, vendors and consulting, and start-ups, leading to higher turnover rates and alternance of national and international appointments. These trends are also affected by the progressive aging of the IT workforce, the positive effect of more women choosing IT and BTM as their career, and increasing influence of personality and values in choosing what type of BTM career fits best a person.

Theory: We propose an extensive stratified survey of BTM professions from all sectors of the economy and across a dozen countries representing all continents. Our objectives are to capture the peculiarities of technology evolution and its impact on career choices, along with the dynamics of interplay between technology and management appointments during career paths. We rely on the Career Anchor model to map factors affecting relative career success. A comparative international study is best to draw contrasting career patterns, and identify converging factors impacting change. In addition, we attempt to rely on how professionals onboard various positions as factors that affect their network-driven success (e.g., Social Networks Analytics, SNA, applied to crowdsourcing and linkedin). These will be linked within a structural model showing factor dependencies and impact on career progression and satisfaction.

Methodology: We will analyze our online survey using 3 different statistical techniques, using Structural Equation Modeling (SEM) path modeling. First, we use the Covariance Based Analysis (CBA) using IBM SPSS Amos and circumvex tests to analyze possible circularity among factors. Second, we use a Partial Least Squares (PLS) method to identify more linkages within smaller samples of our stratified survey.

Third, we use Bayesian Networks to extract factors interdependencies and determine their relative reliability among changing career patterns. Models are assessed primarily with goodness of fit measures, but also discriminant analysis to determine relevance of patterns identified.

Outcome: Our research outcomes shall be helpful to help IS/IT and BTM career planning, both from a personal and a business perspective, by providing clear patterns that lead to success, depending on personality and preparedness for technology evolution. Findings can also be integrated within a broader Human Resources Analytics framework, with career anchors serving as new inputs to Talent Management and career piloting rules-based systems. Impacts will be assessed also at the level of professions, helping to guide the ongoing convergence among many specializations within a broader BTM BOK framework, with empirical guidance for curricula development.

7. DBA PM Thesis – On-Going

Toward an Integrated Capability Model for Artificial Intelligence and Analytics (AIA) Projects

El Chababi, Maria

Dir.: Stéphane Gagnon

Context: Artificial Intelligence and Analytics (AIA) solutions are enabled by recent (often Open Source) advances in Cloud and Big Data infrastructure, along with Machine Learning and other Artificial Intelligence technologies. They are used to support real-time and mobile decision-making, seamlessly integrate information across strategic and tactical organizational levels and thus make organizations more agile and adaptive. These applications are designed to deliver quantum leaps in quality, productivity, and risk management in various industries. For example, identifying which patients are likely to contract certain types of complications to ensure that the right medical staff and supplies are available, identifying which carriers should be closely inspected while crossing borders between countries to greatly speed up cross-border transportation, or understanding customer behavior to identify who is likely to cancel a subscription and therefore take early action to retain the customer.

Problem: While their popularity is growing, especially among large organizations in the retail, finance and telecommunications sectors have successfully implemented AIA solutions, for most organizations these projects remain primarily experimental, with mixed results in following established project management methods. Focusing on these challenges, we propose to develop an integrated capability model for this type of IT and Digital Transformation project, considering the contingency factors of their business context (e.g., private vs. public sectors; small-medium vs. large organizations; product vs. service focus).

Objectives: Our objectives are to help formalize development methods, integrate these projects with others within IT project portfolios, and ensure greater alignment between technology architecture and business requirements.

Theory: We follow on the footsteps of the Project-as-Practice paradigm, along the lines of Strategy-as-Practice. As such, we rely on a comparative analysis of actual embeddedness and emergence of professional project practices.

Methodology: Our study would require the use of 3 approaches, serving different research objectives:

1. **Interviews:** Identifying the key organizational capabilities required for the successful deployment of Intelligent Applications projects, helping to define a set of high-level patterns and a model related to project management challenges.
2. **Survey:** Depending on the quality of our data, develop a causal model of the various conditions and requirements that help explain the key organizational capabilities needed for the deployment of Intelligent Applications projects.
3. **Case Studies:** Synthesize our findings through detailed case studies of actual projects, identifying possible best practice and capability development scenarios.

To facilitate data collection and comparability, we propose to focus the interviews among a handful of AIA executives in both private and public sectors in Canada, and the survey globally in all sectors and regions, relying on our LinkedIn opportunistic sampling of about 100 respondents. The case studies would rely primarily on a traditional positivist, comparative case study analysis, benchmarking AIA teams within the Government of Canada.

Outcome: Our research results would be to help formalize AIA project management and development methods, define ways of integrating these projects with others within IT and Digital Transformation project portfolios, and ensuring greater alignment between technology architecture and business requirements.

8. PhD STI Thesis – On-Going

An Ontology-Based Decision-Making Framework Modeling Power Efficiency for Photovoltaic Systems

Khosrojerdi, Farhad

Dir.: Stéphane Gagnon; Co-Dir.: Raul Valverde

Context: Planning an efficient photovoltaic (PV) system requires defining technical parameters that represent different knowledge areas, especially variables associated with the controller in the power conversion system. PV systems generate less energy under shading conditions or in changing climates. In a PV control system, the application of a maximum power point tracking (MPPT) method is the key factor that enables the PV arrays to operate efficiently in various ambient conditions. It is the system design requirement to define an appropriate MPPT method and the related technical parameters. As a result, dealing with characteristics of an MPPT method is a complex task when planning a PV system.

Problem: In this work, we propose a knowledge base ontology model that represents key concepts associated with designing MPPT-based controllers. The model embodies factors that affect power outputs in various ambient conditions. The proposed ontology aids to determine technical constraints and requirements of the control system and to select an appropriate MPPT method. Furthermore, the ontology model provides system design recommendations, suggestions, and power output corrections that most PV planning tools fail to report. The designed ontology, named MPPT-On, is developed using SWRL rules and queries to deal with shading conditions originated based on snowfalls.

Methodology: Evaluation of the proposed ontology is performed using a case study. We consider two scenarios for PV shading conditions expecting longer and shorter durations for snow coverings. Analysis of three types of datasets: I) output powers reported by SAM model, II) output powers corrected by MPPT-On, and III) onsite measured output powers demonstrates significant improvements by applying the proposed ontology.

Contribution: We propose an MPPT database featured with SWRL queries providing technical design data required for the MPPT-based control system of a PV project. We claim that such a MPPT database need to be added to PV planning tools to including MPPT-based control system. Furthermore, defined rules and queries for MPPT-On provide valuable technical recommendations, design considerations, and output corrections that help system designers and project managers in different phases of a PV project.

Outcome: Using the proposed ontology model helps non-technical end-user to define design-related parameters correctly and plan an efficient PV system.

Integrating Semantic Reasoning in a Multi-Agent System in Erlang

Eloumri, Miloud

Dir.: Stéphane Gagnon

Context: Since the revolution of Object-Oriented Programming (OOP), and especially since about 2005, software is undergoing its next revolution towards explicit concurrent and parallel programming due to the industry major change to the parallel hardware. As a result, parallel, heterogenous, and distributed hardware and systems have become the mainstream available universally in personal computers, smaller devices, and networked applications. This fundamental parallel hardware shift requires seeking the best ways to address the challenges of explicit parallel programming and properly utilize multicore and distributed CPUs. Multi-Agent Systems (MAS), consisting of agents that operate and cooperate concurrently, are traditionally modeled based on OOP concepts, mainly Java programming language as a mainstream of OOP.

Problem: However, the nature of MAS and their fundamental assumptions contradict with OOP principles, especially in terms of OOP shared memory model, and its inherited complexity of concurrent programming as well as its lack of native support for intelligent aspects of agents. Recent trends show that functional programming paradigm provides promising strategies of abstraction and features specifically meeting the requirements and addressing the complexity of concurrent or parallel programming including MAS features. Among several functional programming languages, Erlang functional programming language provides one of the most straightforward and inexpensive approaches to exploit distributed and multicore CPUs concurrently efficiently as well as to provide all-in-one environment to program all aspects of MAS.

Methodology: This research proposes to reuse and extend the capabilities of 2 open source Erlang libraries, erlang experimental Agent Tool (eXAT) and Swarm oriented Erlang Expert System Engine (SERESYE), by integrating semantic web knowledge models and standards such as Resource Description Framework (RDF) data structures and Web Ontology language (OWL) ontologies in a rule engine that allows agents to perform various tasks of reasoning and analysis over such emerging knowledge models and standards. We propose to demonstrate well-known use cases, such as the Book Trading case of Java Agent Development (JADE). Moreover, the system will be made available via a web portal for users testing and feedback. The feasibility and efficiency of the system will be evaluated based on the recall and precision of the rules-based scenarios, vs. actual optimal decisions, and performance metrics including use of resources, time, and scalability.

Outcome: This demonstration of how we can integrate semantic reasoning in a multi-agent system will allow us to develop more complex and intelligent collaborative systems. The applications will be numerous, primarily in Robotic Process Automation (RPA) in Industrie 4.0, and other rule-based and formally defined problems.

10. PhD STI Thesis – On-Going

Implementing Business Technology Management with an Ontology of Cybersecurity Professional Skills

Léger, Marc-André

Dir.: Stéphane Gagnon; Co-Dir.: Raul Valverde

Problem: Standards of professional cybersecurity skills are numerous and complex. They are difficult to integrate and exploit for talent management in organizations. We propose to take advantage of the Business Technology Management (BTM) to facilitate the integration of skills repositories, proprietary standards, and open standards.

Methodology: Using an Action Design research methodology, we propose to develop and test an innovative ontology of cybersecurity professional skills for talent management of large organizations, specifically in the financial services industry in Canada. Our open collaborative development lifecycle involves a community of experts.

Contributions: We make contributions through three scientific articles:

- First, we present how the ontology will be built, in the second we present how the ontology is mapped to our subject domain and, finally, in the third article we build and validate the ontology, as presented in the first article: ***Ontology engineering methodology for cybersecurity requirements in Business Technology Management (BTM)***.
- Second, following what was proposed in the first article, we will create the ontology using OWL Protégé corresponding with the requirements of a large Canadian financial institution aligned with the National Cybersecurity Workforce Framework (NCWF) (NIST) from the National Initiative for Cybersecurity Education (NICE) by the National Institute of Science and Technology (NIST). This work is presented in the second article: ***Ontology alignment between cybersecurity competency reference models and the requirements of large financial institutions***.
- Third, we will look at the opportunity of using the ontology to help a large Canadian financial institution in the management of cybersecurity talent: ***Cybersecurity ontology as a rules-based competency management system in financial institutions***.

Outcome: This study should contribute to improve information security and risk management performance in the field of Business technology Management and Cybersecurity. A better understanding of the competency needs of financial institutions will help to reduce vulnerabilities associated to the human factor caused by gaps in competencies, knowledge, skills, and abilities as well as the talent shortage. The human factor remains the biggest security hole in organizations and solutions are lagging. By creating a tool that will help to match individuals, competencies, competency frameworks, organizational requirements, and obligations, we can significantly impact the effectiveness of risk management activities and the efficiency of cybersecurity.

11. PhD STI Thesis – On-Going

Business Technology Management Semantic Integration for Automated Project Team Composition

Torres, Beatriz

Dir.: Stéphane Gagnon; Co-Dir.: Raul Valverde

Context: Business Technology Management (BTM) is a rapidly emerging trans-disciplinary research area and professional discipline in Business Administration. It seeks to provide an integrated framework for the strategic use of Information and Communication Technology (ICT) and leading digital organizations.

Problem: The present thesis proposal is part of the BTM Body of Knowledge (BOK) project, seeking to develop a systematic, exhaustive, and evolving framework for professional practice standards, in service to support IT Human Resources Management (HRM). The project aims to make BTM job knowledge easily accessible, customizable, and reusable for decision-making by professionals, employers, higher education, and other associations involved with IT-related standards, certification, and accreditation.

Objectives: The present thesis proposal is for standards reuse through BTM Semantic Integration technologies for the purpose of Automated Project Team Composition. Our thesis is focused on a key task within the BTM BOK development lifecycle, namely the reuse of the BOK assets stored in XMI/XML, with references and mappings to relevant parts related to BTM BOK core. A key issue is to reuse and add value to the standard job descriptions, their tasks, and job qualifications, which can be used for automated team planning. This will help overcome the difficulties in managing BTM career paths, as many professionals and their hiring managers face ambiguity as to what BTM standards are the right one for what job roles.

Methodology: We propose to use text mining and semantic annotation technologies, along with XML/XMI and semantic query, to help extract, validate, expand, and integrate BTM standard components stored in XMI (i.e., roles, tasks, processes, competencies, artefacts, tools, etc.). The logic of the proposed system relies on the fact that:

- BTM standards are stored in an XMI format conforming to the XML standards by Object Management Group (OMG), namely Software Process Engineering Metamodel (SPEM 2.0).
- Job roles, tasks, and qualifications are clearly separated under their respective component, and can be surgically parsed and integrated within various other XML documents and queries.
- This data can be further annotated using an ontology-driven semantic text mining tool, so as to help us query them further and ensure their validated integration with other components, e.g., customizing a job profile.
- The semantically linked job profiles can then be combined to form a team as per project requirements.

Software: This study relies on a text and semantic analysis platform, ARDAKE tool (e.g., the Adaptive Rules-Driven Architecture for Knowledge Extraction, ARDAKE, <http://www.ardake.com>), developed by UQO Student Dr. Wassim El-Kass. It will be used to annotate the BTM BOK resources, and then perform semantic queries to extract job roles, tasks, and qualifications, which will then be expanded into accurately configured team compositions, which are then validated using the semantic relationships.

Outcome: This study will allow to insert semantic annotation of BTM components that can leveraged to expand and properly assemble the job roles in an automated project team composition system. Further empirical verification will be done using publicly available samples of BTM job descriptions and typical teams.

12. PhD STI Thesis – On-Going

BTM Standards Integration within Talent Management Processes: An Ontology Engineering Approach

Elgebli, Jamal

Dir.: Stéphane Gagnon

Context: The e-Recruitment process has become an essential functionality in electronic Human Resource Management (eHRM). It allows to minimize the search time and provide best recruitment services. In essence, Curriculum Vitae (CV) is crucial in the recruitment process.

Problem: Many researches have discussed the use of several standards, such as HR-XML and ontologies with the aim of solving various problems and providing enhancement for automatic and optimized CV processing. However, the lack of a generic CV standard has negatively affected the efficiency of the e-Recruitment process.

Objectives: To address this lack, we propose to develop a more generic CV model that allows flexible reuse and conforms to competency models. We use Business Technology Management (BTM) discipline with its formal learning outcomes and competency standards as a framework to apply and validate our approach.

Methodology: We test our new XML standard by enabling systems integration of Talent Management processes in eHRM applications. We build upon existing professional credentials in XML and XMI and integrate them to automate the exchange and validation of data as per BTM standards published as services.

Outcome: The main outcome of this research is to promote job descriptions reuse and CV data interoperability automating several e-Recruitment and management tasks.

13. PhD STI Thesis – On-Going

Business Technology Management Standards Integration and Semantic Validation

Sidenko, Svetlana

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Context: The discipline of Project Management (PM) was among the first to develop a Body of Knowledge (BOK), a guide to the roles and practices of the profession. These contents are presently being integrated within a new emerging initiative, Business Technology Management (BTM). BTM is an emerging trans-disciplinary research area and profession, uniting Information Systems (IS) and Information Technology (IT), 2 disciplines respectively in business and computing schools. It seeks to provide an integrated framework for the strategic use of technology and leading digital organizations. Each BTM specialization has well-established international associations, with certification levels supported by proven frameworks uniting best practices. These include Business Analysts, IT Services Management, IT Governance, IT Project Management, among 20+ specializations covered by the BTM Body of Knowledge (BOK) in development.

Problem: BTM professionals are submitted to increasingly complex career choices, with factors that impact their progression primarily driven by technology evolution, learning pace, and industry dynamics. Among other issues we find that:

- Schools must adjust curricula for IS/IT and BTM to ensure employability of students in new markets, requiring more systematic career literacy programs.
- With more diverse specializations and certifications required for salary progression, professionals are greatly constrained by competition, yet it is still unclear to what extent multiple certifications help them move along their careers, and what mix is best within an investment model of BTM jobs.
- There is also a shift away from traditional career progression (e.g., moving through Business Analysis, Project Management, and IT Services Management), which implied loyalty and promotion through ranks of a typical corporate IT division, toward diverse assignments with IT and business units, vendors and consulting, and start-ups, leading to higher turnover rates and alternance of national and international appointments.
- These trends are also affected by the progressive aging of the IT workforce, the positive effect of more women choosing IT and BTM as their career, and increasing recognition that personality and values play a major part in choosing what type of BTM career fits best a person.

Objectives: The present thesis proposal is an extension to the existing PM and PMBOK to develop the BTM Body of Knowledge (BOK), seeking to develop a systematic, exhaustive, and evolving framework for professional practice standards, in service to support IT Human Resources Management (HRM). The BOK project aims to make BTM job knowledge easily accessible, customizable, and reusable for decision-making by professionals, employers, higher education, and other associations involved with IT-related standards, certification, and accreditation.

Contributions: The present thesis by 3 articles seeks to validate the structure and contents of the Business Technology Management (BTM) Body of Knowledge (BOK). Our objective is to help extract and

validate new relationships between standards and their many components (i.e., roles, tasks, processes, competencies, artefacts, tools, etc.). We make contributions through three scientific articles:

- First, we use a Design Science and Ontology Alignment methodologies to develop a new ontology for the field of BTM. It is validated using existing ontologies such as WordNet and published ontologies on the field of Information Systems and Information Technology. It builds upon the integration of existing PM BOKs, and some PM metamodels to help structure the contents of the BTM BOK, e.g., Object Management Group (OMG) standard Software Process Engineering Metamodel (SPEM 2.0).
- Second, we use the ontology built in paper 1 and use several techniques to find the commonalities between 1729 items and statements from 20 different BOK reference models. We integrate mostly open source libraries of Ontology Matching, Ontology Alignment, Semantic Annotation, Semantic Distance, and Text Classification. The objective is to identify a sub-set of similarities to simplify the integration of several BOKs into a single core BOK, based on a new ontology for the field of BTM.
- Third, we verify the findings of paper 2 by collecting the many community-contributed mappings among BOK items and statements, reusing their logical structure to create a consensus graph of the many BOK items relationships. We estimate the semantic distance between this graph and the one proposed by the formally-validated BTM ontology, identifying in which areas of the BTM BOK more formal and empirical validation efforts should be required, and identifying possible methodological shortcomings or quality assurance issues in the overall BTM BOK development lifecycle.

Outcome: Our research outcomes shall be helpful to help IS/IT and BTM career planning, both from a personal and a business perspective, by providing clear patterns that lead to success, depending on personality and preparedness for technology evolution. Findings can also be integrated within a broader Human Resources Analytics framework, with BTM BOK mappings serving new inputs to PM Talent Management and career rules-based systems. Impacts will be assessed also at the level of professions, helping to guide the ongoing convergence among many specializations within a broader BTM BOK framework, with empirical guidance for curricula development.

14. PhD STI Thesis – On-Going

Intelligent Systems and Ontology-Driven Engineering (ODE) for Migration, Integration, and Service of Heterogenous Enterprise Resource Planning (ERP) Platforms

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Context: Migration or integration between Enterprise Resource Planning (ERP) Platforms involve the complex identification of relevant components, seeking to improve system alignment with business requirements. This is particularly challenging in the case of inter-organizational (supply chain) systems requiring the use of service-oriented, as well as federated ERP architectures, with sensitive information proprietary and security concerns. This is exacerbated by the combination of both proprietary systems, Commercial Off-The-Shelf (COTS), and open source ERP solutions. ERP migration and integration are among the top risks of these projects, often preventing effective project planning and hampering innovation in next-generation systems. At a broader level, it is linked to challenges of planning Enterprise Architecture (EA) evolution over several years.

Problem: We propose to use Ontology Matching, a rapidly growing research area in Semantic Web and Knowledge Reasoning, as a sub-set of Software Engineering and Artificial Intelligence (AI). As a solution to solve the ERP migration and integration challenges, we focus on linking software runtime components, databases, workflows, end-user interfaces, and rules and policies. Ontology Matching is a special case of Ontology-Driven Engineering (ODE) in Model-Driven Engineering (MDE) and Information Systems Design (ISD), as effective approaches to managing the architecture and design, while ensuring uniformity and conformity of all tasks of IT projects.

Objectives: We propose to develop a new intelligent system and methods in ERP migration, integration, and service. It will rely on the latest semantic technologies and Ontology Matching algorithms. Our goal will be to ensure coherence between requirements and architecture within an ODE approach. We seek to evaluate the relative value added from these technologies to help architects and development teams reconcile new requirements with existing architectures and recommend alternative design patterns.

Methodology: We propose to rely on the Action Design Research methodology, seeking to experiment iteratively in developing innovative solutions for software engineers and architects. We will install and configure our lab environment for Ontology Matching, using the High-Performance Computing (HPC) servers of Compute Canada. Our testbed for ERP migration and integration will use open source ontology management platforms. A laboratory experiment will be performed to analyze the requirements of actual IT projects, involving a series of maintenance and extensions projects made to an existing commercial package, with migration from an Open Source (e.g., Odoo) to a commercial (e.g., Microsoft Dynamics AX) Enterprise Resource Planning (ERP). Our lab will rely on open source ontologies of business domains as the middle-ground Ontology Matching core.

Data: We will process these data sources, studying various configurations Ontology Matching systems, and attempting to automatically identify potential risks and conflicts between requirements and architecture of the databases and components of several ERP systems. This will allow us to evaluate to what extent it is possible to detect conflicts early in the development process, which detection methods

are most effective, and what detection rules can be formalized to help support architecture decision-making throughout a software project.

Outcome: Our proposed solution can help highlight potential design conflicts in the migration and integration of heterogenous ERP systems. This task is most crucial when new system requirements, functional or non-functional, are being integrated to a project, but must be properly flagged as either incoherent, hard to integrate, or simply have too many change points as they are fitted within the overall system architecture. Poor results in classifying new requirements as easy or problematic can lead to snowball effects, with other components affected and creating undue risk for project delay or failure.