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Ontology-Based Knowledge Flow Model Design to Develop Global Virtual Team (GVT) Performance

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A B S T R A C T

Global virtual teams (GVTs) have grown in popularity as a result of increased globalization and advancements in communication technologies. GVTs are playing an increasingly important role. Little is known about its strategy, dynamics, or efficacy in global organizations. Many researchers have focused on virtual teams but have not supported semantic search techniques and the ability of GVT knowledge to be understood by people and computers. This study was therefore aimed at building an ontology-based knowledge flow model for improving GVT performance. The Mapping Master domain-specific language (Mapping Master DSL) technology was used to build the ontology. It enables the creation and linking of concepts and individuals to the ontology using Excel sheets. The conceptual framework was built using the object role modeling (ORM) language. The SPARQL query was used to test and evaluate the proposed ontology..

1. Introduction

Nowadays, access to information is regarded as a valuable feature for the user and is a critical component of acquiring knowledge. Regardless of the traditional web's role in publishing and information participation, users are unable to obtain or retrieve information in a timely and accurate manner. As a result of information exchange and retrieval, ontology, which is an important component of the semantic web, has been developed. The Semantic Web is a natural extension of the current web. It alludes to the effort of transforming the recent web from a large depot of unstructured and untidy material to an ordered digital depot or a massive database that is linked to them by linkages based on comprehending the meanings of, and relations that make its interconnection with well-connected information simple to search for and use. The semantic web requires that terms have defined meanings for machines to automatically analyze and display content on the web, and whoever provides these definitions is the ontology. The term “ontology” describes the specification of conceptualizations used to assist programs and humans in sharing knowledge [3]. The separation of domain knowledge from application knowledge, the definition of terms, concepts, categories, and entities in a specific domain with the goal of modeling and formulating relationships between them, and the reuse of domain knowledge for a variety of applications are some of the potential benefits of ontology in representing and processing knowledge. The most important semantic web language used in ontology creation is Web Ontology Language (OWL). The World Wide Web Consortium

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developed OWL as a semantic coding language for creating and slicing ontologies on the internet. It represents a significant advancement in the semantic web movement.
There are no set methods or methodologies for building an ontology for a specific topic of knowledge; instead, to get started, the following broad questions need to be answered [4]:

1) What is the ontology's area of coverage?

The proposed ontology will cover the domain of global virtual teams, including the people, teams, companies, ICT used, conflict, language and performance for each person, team synergy, team orientation, and relationships with each other.

2) Why do we utilize ontology?

For a variety of applications that deal with GVTs, such as information retrieval, viewing GVTs, and their performance, as well as the factors that affect them.

3) What kinds of questions could ontology answer?

Information about a person, teams, and companies to which the individual belongs, the means used for communication between members of the same team, as well as the certificates obtained by the person. This could be whether the person had any previous work or training, the reasons for disagreement among team members, and the individual's language level in terms of listening, speaking, writing, and directing the team and synergy.

4) Who will look after and use the ontology?

Many are interested in the field of GVTs because teams have spread rapidly in the recent period following the coronavirus pandemic, which swept the entire world, causing work disruptions in many countries and preventing physical movement at the local and global levels [1]. Virtual work is not a new concept. Multinational corporations operate virtually and form GVTs, which are defined as a group that is temporally, culturally diverse, geographically dispersed, and electronically connected [2]. For example, in the field of information and communication technology (ICT), virtual teams, like traditional teams, are affected by factors that can affect them negatively or positively. These factors include, as stated in the literature, "conflict, trust, methods of communication among team members, individual performance within the team, language and cultural difference, and other factors". One of the benefits of developing and working in a GVT environment is the ability to collaborate on a project despite geographical differences. According to Jimenez and coworkers [6], GVT participants do not have to travel to work on a project, which saves a substantial amount of time and money. Furthermore, the distribution of participants across time zones can enable a 24-hour workflow, making project monitoring and completion much easier. Organizations hire the brightest minds to join their teams, regardless of where they are located, to increase the company's efficiency [7]. The four fundamental characteristics of virtual teams are; They are transient (structured for a specific job), culturally diverse (multiple nations and languages), geographically dispersed (working from remote locations), and electronically connected (via ICT) [8] Virtual teams have a distinct culture. Depending on how the space is divided and diversified, each squad has a different configuration [9]. Organizations face several challenges as a result of virtual teams. In addition to technological challenges, there are social and psychological factors to consider [10]. Virtual teams focus on knowledge-intensive tasks that necessitate information sharing and exchange.This included multiple ICT teams, multiple companies, a group of people, as well as factors affecting teams such as conflict, communication, language, and performance. The field of ontology focused on the individuals within the team, the means of communication between them, causes of conflict between members, years of team experience, synergy, and direction for the team. It also focused on the individual in terms of name, age, date of birth, gender, country, account, years of experience, training and certificates obtained, whether he had previous work, and his proficiency in the language used among team members in terms of (listening, speaking and writing). We did then constructed an ontology using a protégé editor and assessed it using a SPARQL query [4]. Tables of concepts, binary relations, and attributes made up the conceptual model that was utilized to build the structure of the ontology.The rest of the paper is laid out as follows: The related works to this research are presented in Section 2, the method utilized to perform this research is discussed in Section 3, while section 4 discusses the proposed model, the results and discussion of this research in Section 5, finally the conclusion and future work in section 6.

2. Related Work

Global virtual teams have spread in recent years, and companies interested in cultural diversity have focused on GVTs, especially after the coronavirus pandemic, which caused work disruptions in most countries. Many researchers have also focused on the field of GVTs; some are interested in looking at performance criteria and developing a conceptual model that could be used to assist virtual project teams in succeeding. In managing virtual project teams [22, 23], examined the relationship between management, cultural diversity, and virtual teams, as well as how managers can overcome or at least mitigate the challenges that teams face when working. Meanwhile, how different types of team diversity in the GVT relate to conflict, the role of technology in conflict in the GVT, and how task characteristics can affect conflict processes and outcomes in the GVT were concentrated on.[24] Presbitero,[1] has also examined factors that contribute to the efficacy of both the interpersonal processes of synergy and orientation in GVTs. The researchers focused on determining the factors that affect the performance of GVTs and what the rank of the factor that affects the performance of GVTs based on its level of impact on the performance of GVTs [25]. In a study conducted by Gliksona [26], he revealed the subtle dynamics of early asynchronous team communications, emphasizing the critical role of the first e-mail. It clarifies the role of the first message as an indication of the suitability of relational content for use by team members during early asynchronous communication [27]. Also, research showed that MedicDev lacks an organized strategy for virtual teaming [28]. Study shows that GVT managers must recognize and consider foreign language anxiety, which may result from having poor language skills. GVT members who are suffering from significant levels of foreign language anxiety should receive extra help and support [29]. Davidavi [30], examined how a limited set of communication options might affect the effectiveness of a worldwide virtual team. Measurement of the impact of culture, motivation, language, conflict, ICT, trust, and leadership on knowledge sharing in virtual teams has been investigated.[31] The study concluded that efficient GVT interaction is made up of a succession of communication episodes. Based on a review of the literature, it was discovered that previous works did not focus on the field of developing the GVT using ontology. Table 1 displays previous work (systematic review) on GVT.Therefore, this study was conducted to build an ontology-based knowledge flow model to develop global virtual team (GVT) performance.

Table 1. Systematic review of global virtual team.

Research	Year	Aim	Result and conclusion	Gaps and future work
30	2020	Measure the impact of the following aspects on knowledge sharing in virtual teams: culture, motivation, language, conflict, ICT, trust, and leadership. As a result, the following research question was developed: Are there any positive or negative correlations between information sharing procedures and culture, motivation, language, conflict, ICT, trust, and leadership?	In terms of culture, motivation, conflict, ICT, trust, and leadership, our findings in the UAE are comparable to those found in European and American studies. Language, on the other hand, has been demonstrated to have a substantial impact on VT knowledge exchange in Europe and the United States, but not in the UAE.	1-The study only looked at seven elements that affect information sharing; however, there are additional aspects that affect knowledge sharing that was not included in this study. 2- The study only looked at IT firms; future studies should look at other industries. 3- Although this study was conducted in the United Arab Emirates, future research should

				involve other countries.
31	2000	1- Claim that efficient global virtual team interaction is made up of a succession of communication episodes, each of which is shaped by structural and process features of the team. The shape, decision process, and complexity of an interaction incident were all found to be related to effective results. 2- Effective global virtual teams order these occurrences in such a way that they create a deep rhythm of regular face-to-face incidents mixed with less intense, shorter incidents using multiple media. These two ideas are examined in light of other research and expanded upon in various statements. There are additional implications for research and practice.	The claim is the conclusion that two of our three teams, MakeTech and SellTech, were effective, with SellTech being the most effective. The judgments and activities of the members and executives were deemed satisfactory. Team members evaluated their processes as effective, and they indicated a high level of commitment to the team and team cohesion, which matched our findings and analysis. NewTech, on the other hand, was shown to be ineffective as a global virtual team. The team didn't make any decisions regarding the new product and didn't take any steps to properly create it. The majority of those who replied did not give their processes or cohesion high marks, and we did not see them communicating with the rest of the group. Although New Tech's ineffectiveness was a bad consequence for MTI, it supported their study by offering a theoretical replication case on the performance variable. They focused on the parallels and contrasts between MakeTech and SellTech, as well as the disparities between them and NewTech, to develop theoretical insights from this investigation, identifying variables and relationships that influenced outcomes.	1-Clearly, it gives a collection of well-founded ideas for additional research into global virtual teams. These general ideas can be tailored to unique teams and organizations by researchers. 2- Although research has proven that culture affects information system use and that cross-national teams struggle to build trust, our pairing of specific sorts of cultural differences with specific features of the global virtual team process makes a significant contribution. Our sample features, on the other hand, prevented us from making broad generalizations about which additional background and context aspects would have the greatest impact on processes and when. This is unquestionably a promising area for future investigation. 3- Finally, this study recommends some future approaches for organizational and group research.

22	2016	The aim was to look at performance criteria and come up with a conceptual model that might be used to help virtual project teams succeed. In managing virtual project teams, there are no clear parameters for performance criteria.	Leadership, trust, communication, team cooperation, reliability, motivation, comfort, and social interaction were recognized as performance characteristics for virtual project teams in the study. These were utilized to develop the model's concept.	1- The conceptual model can thus be used by the project manager to identify gaps in either the three performance levels or the contributing elements. The conceptual model can be used to estimate the virtual team's total performance holistically, but each aspect can be examined separately to determine its impact on the overall performance.
27	2015	Using information acquired through reviews of the literature on virtual teams and collaboration tools, as well as an examination of the virtual team experience in a modern international firm, design a model for the installation and administration of virtual teams.	This research revealed that Medic Dev lacks an organized strategy for virtual teaming. The emerging character of this type of cooperation, as well as the rapid proliferation of technologies that can promote collaboration among distributed workgroups, can explain this to some extent. As a result, many firms are likely to lack an appropriate structure for virtual teamwork.	1- In many firms, the lack of an appropriate structure for virtual teamwork is to be expected. More investigation is needed to see if this is the case.
25	2016	The goal of this study is to address two research questions: 1. The first research question is to determine the characteristics that influence the success of global virtual teams. 2. The second study topic concerns the ranking of factors impacting the performance of global virtual teams based on their amount of impact on global virtual team performance.	Cultural differences, language problems, time-zone differences, team size, technical problems, lack of trust, insufficient training, and ICT problem were all explored as variables that affect the functioning of global virtual teams. In addition, the research revealed that a lack of adequate training has the greatest impact on the effectiveness of global virtual teams. Team size, on the other hand, has the smallest impact on the success of global virtual teams.	1. A future study should be undertaken to improve the performance of global virtual teams in global software projects, taking into account all of the criteria highlighted in this research report.
26	2019	This research aims to contribute to the body of knowledge on intercultural team	The relational content of the first conveyed message and the relational nature of the early asynchronous team	1- Future research should broaden the sample to additional populations to

		communication by making the following theoretical and practical contributions. 1- It shows how early asynchronous GVT communication affects the formation of a team communication atmosphere. 2- It emphasizes the relevance of the relationally-oriented content of early asynchronous GVT communication as a substantial antecedent of the PSCC, rather than the task-oriented content, and provides additional evidence of the positive effect of this environment on GVT performance. 3- It emphasizes the anchoring effect of the very first email, revealing the micro-dynamics of early asynchronous team communication. It highlights the first message's role in communicating the acceptability of relational material for team members to employ during the early asynchronous conversation. 4- by focusing on early intercultural team communication and connecting team micro-dynamics to communication theories.	communication has a substantial association. There is also a link between the relational content of early asynchronous team communication and the PSCC of the team, as well as between PSCC and team performance. Furthermore, when there was a higher proportion of a woman on the team, the related content in early asynchronous communication was higher.	improve the generalizability of the current study. 2- Future research should focus on communication content that combines relational and task orientations, as well as other communication factors including communication frequency, communication channels, dominating participants in the communication exchange, linguistic form and tone, and so on. 3- We propose that the current study's contributions be expanded to include the dynamics of team communication and their impact on team performance and other team behavioral outcomes in long-term teams.
28	2019	This study shows that GVT managers must recognize and consider foreign language anxiety, which might result from having poor skills in a foreign language. GVT members who are suffering significant levels of foreign language anxiety should receive extra help and support. GVT members who are experiencing trouble learning a foreign language should be able to take language classes.	Their findings on the three aspects of cultural intelligence add to the expanding number of studies looking into how each degree of this sort of intelligence contributes to effectiveness in cross-cultural encounters. Using 294 data pairs (collected from GVT members and their respective supervisors) in a multinational offshoring firm, they found support for the mediation process and the conditional influence of the dimensions of cultural intelligence in reducing the negative effect of foreign	1-For future research, using a more rigorous and objective test of foreign language skills would be useful because the results would be more reliable. 2- Future studies should take into account aspects such as team composition (e.g., team members' familiarity with one another or the number of persons

		Similarly, appropriate teaching and monitoring should be in place to assist GVT members who are anxious due to their low foreign language skills.	language anxiety on individual task performance in GVT.	on the team who speak a foreign language), as these can greatly lower anxiety over time. In future studies, the cultural difference between the countries participating in the communication should also be taken into account. 3- Because the samples in this study came from only one country, they cannot be said to be generalizable. Future research should be carried out in a variety of countries and cultural circumstances. As a result, the replicability of the results would be determined, and the validity of the research findings would be further strengthened.
32	2018	Providing a complete examination of selected ontology learning methods and their characteristics. An attempt at taxonomy construction is based on this, and it includes a set of selected methods and their parameters. The author's technical contribution comes in the form of conceptualizing ontological domain knowledge. The provided ontology provides a collection of various sorts of methods, as well as essential information on how they are employed in distinct approaches.	The suggested author's ontology provides for both OL technique knowledge and a thorough usage guide. The author believes that the ontology construction procedure has been completed satisfactorily. The set of competence questions was used to verify the accuracy of the ontology, and the results were provided by them. The suggested author's ontology is currently in the form of a pilot study and serves as a foundation for further development.	1-Researching transfer learning and ontology reuse could aid in the adaption of current ontologies to new domains by reusing existing schematic structures in part. 2- Crowd sourcing ontologies, which mix the speed of computers with the accuracy of humans can be a potential alternative to solely automatic techniques.

29	2016	Examine how a limited set of communication options might affect the effectiveness of a worldwide virtual team.	The result suggests that communication may play a role in team effectiveness, albeit the limited number of communication means used was not the primary determinant. A comparison between the co-located management team and the worldwide virtual divisional team emphasized this.	1-Future work suggests a binary approach in order to understand the different perspectives of each type of relationship
1	2021	1- They hope to fill gaps in the literature by presenting a new methodology for evaluating GVTs. 2- In addition, they look at elements that influence the effectiveness of interpersonal synergy and direction processes in GVTs. 3-They'll look at the role of cultural intelligence (CQ), or the characteristics that allow a person to function well in a culturally diverse environment. 4-They also look at the role of communication accommodation, which is defined as a person's communicative action or behavior that aims to "construct, maintain, or reduce the social distance in interaction."	The results show that the HTMT ratios are all less than 0.85, indicating that the components in the study have discriminant validity. They looked at additional indices as well, following the PLS-SEM suggestions. They investigated collinearity by analyzing the inner VIF, and the results indicate values of less than 3, which is appropriate for determining the absence of any critical collinearity difficulties.	1-The study did not look at the distal effects of interpersonal synergy and direction processes. Objective measurements of team success (e.g., project completion or customer satisfaction) could be achieved in future research that builds on the current study's research paradigm. 2- Future studies can theorize and practically test potential mediator modifiers. The CQ of a supervisor or top management team, for example, can be investigated as prospective mediators in the mediation process. 3- In terms of data sources, the major responders nominated peers to collect outcome data (i.e., efficacy in interpersonal processes of synergy and direction). While this method has addressed some frequent method bias issues, future research can improve on this by having random peers remark on the primary respondents' performance.

				4-The research was carried out at a multinational information technology outsourcing firm that may already have the structures and support systems in place to ensure that GVT members perform well. As a result, future research could look into GVTs in other sectors or industries.
23	2006	1-We'll look at culture from the perspectives of two of today's most prominent comparative cultural theorists, Hofstede and Hall. 2- We'll look at the relationship between management, cultural diversity, and virtual teams, and how managers may help teams overcome or at least mitigate the challenges they face when working remotely. 3- A variety of ICTs that are employed in virtual teams will be assessed. These technologies will be examined in light of the cultural characteristics indicated in the first part, to give managers a framework for selecting the best "fit" ICTs for their teams' needs.	After face-to-face communication and meetings, video-over-IP may become the greatest alternative for people from many countries, particularly those with high context cultures. It can solve the major issue of creating trust amongst members of a team who have never met before. The fact that none of the present ICT solutions are perfect in all scenarios or cultural contexts is one of the apparent obstacles for the team manager. As a result, a variety of communication and other ICT tools should be available, and personnel from various cultural backgrounds should be able to use whatever ICTs they like. People can develop their unique skills by efficiently using ICTs and appreciating diversity by inviting, acknowledging, and fostering differences among themselves. This will aid in the formation of effective and competitive virtual teams in the long run.	
24	2007	1-In GVT, how are different types of team diversity related to conflict? 2-What role does technology play in GVT in terms of conflict? 3-In GVT, how do task features affect conflict processes and outcomes	This work advances our understanding of conflict in GVT in various ways by conducting an in-depth investigation of conflict incidents in three GVT: 1-It confirms that certain parts of earlier conflict theory for traditional teams apply to GVT. The association between functional diversity and task conflict, for example, can be extended to GVT from typical teams. In addition, task characteristics have a moderating	1-Future research could build on Figure 2's model by looking at the effects of communication technology characteristics and functional diversity on relationship conflict. 2-A more detailed understanding of conflict categories (such as process

			effect on the links between conflict and team performance in both traditional and GVT teams. 2- This research applies various features of earlier theories to GVT. Cultural (including national and linguistic) variety, for example, has been proven to cause far more conflict in GVT than in traditional teams. GVT has also been shown to have a link between cultural diversity and task conflict. 3-This research identifies the role of communication technology is causing conflict in the GVT. It highlights two technological aspects that cause task conflict in GVT (a high amount of electronic communication and a lack of immediate feedback). This is significant since GVT relies heavily on communication technology and should be mindful of the potential ramifications. 4- The association between conflict attribution and conflict resolution procedures in GVT is explored in this study.	conflict) and conflict resolution tactics (such as accommodating and compromise) could be considered. 3-The relationship between the type of dispute and the technique used to resolve it could be investigated. 4-Other cultural characteristics and their impact on conflict resolution approaches could be examined as well. 5-Aside from team performance, other outcomes such as satisfaction and the feedback effects of outcomes on conflict antecedents could be explored. 6-Large-scale surveys can be used to assess the generalizability of the relationships in Figure 2's model.
35	2022	the aim of this paper to design a meaningful and accurate scale for identifying and analyzing virtual team leadership traits of persons in multinational corporations	The "Cronbach Alpha Coefficient" was examined. As a result, the survey's dependability rating is 0.94, which is acceptable. It has also demonstrated that the scale is both valid and reliable.	1. In additional in-depth assessments of the scale's empirical features will have to wait for a larger study. 2. Using this scale, a succession of academic research projects in this sector will be sparked. 3. These research may expand empirical analyses by using larger samples or by developing different spin-off measures that are appropriate to diverse cultures or working situations.

3. Research Method

Three activities were carried out to achieve the goal of this research. Firstly, a review of previous studies on the topic of the research was made, employing the following keywords, “global virtual team development, development of GVT using an ontology, and factors affecting global virtual

teams". Second, existing research was analyzed, filtered, and summarized to provide a systematic review, and third, a model for establishing a GVT was proposed and designed.

4. Proposed Model

In this research, a framework for constructing the proposed ontology was developed. Fig. 1 depicts the methods used to create the GVT ontology, which consists of four stages:

Phase 1: Expert Questionnaire

An expert questionnaire was created to validate the design of an ontology-based knowledge flow model for the creation of GVT performance. In the process of developing a worldwide virtual team, nine experts were requested to validate the suggested knowledge model. The framework was created to aid organizations and businesses to comprehend the flows of information in worldwide virtual teams. Knowledge from various sources is distributed and flows through development processes. Virtual teams' knowledge flow within the team and development procedures serve as a reference for the hierarchy of knowledge transfer and knowledge demands. All of the experts' responses were positive and of high quality. The experts' chosen response was graded on a five-point Likert scale, with 1 indicating the worst and 5 representing the best [1, 35].

Phase 2: Gathering Information

Data on individuals, teams, companies, performance, language, conflict, and ICT used with them were gathered from credible sources at this stage. This data was processed in three simple steps to make it easier to work with and gain more benefit from it. These steps include:

1. Observing concepts that can be used to create a worldwide virtual team ontology.
2. Following the acquisition of the concepts, they were classified into fundamental principle and sub-concept categories, with a base class belonging to the thing's class and a subclass of a cultural difference class such as category performance (Table 2).
3. Following the categorization of relationships, they were sought. Consideration was given to these concepts (categories) so that the concepts can be related to one another and the meaning can be obtained completely. These ideas and their connections were then represented in Excel tables. More work was put in, and information was gathered in an organized and consistent manner to profit later in the phases.

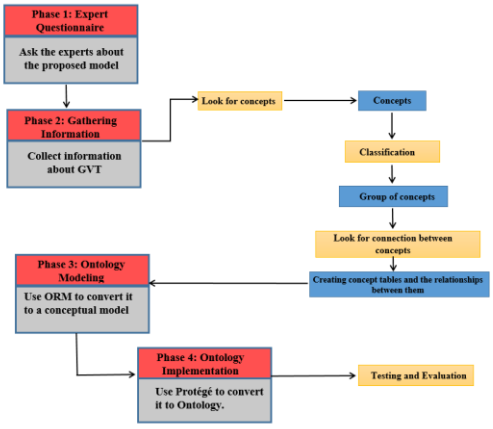

Fig. 1. Methodology for building an ontology for a global virtual team.

Table 2. Classes of global virtual team ontology.

No.	Superclass	Sub class	Class	Description
1	Thing	ICT class, Performance class, language class, conflict class	Cultural difference	Representing the method of communication between team members, as well as performance, conflict causes, and language proficiency
2	Thing	-	Person class	Representation of people within the global virtual team.
3	Thing	-	Team class	A group linked in a common purpose
4	Thing	-	Company class	Representing a group of people to achieve a specific goal
5	Thing	-	Synergy class	Representing the way synergy of the team
6	Thing	-	Direction class	Representing the direction in which it is directed to achieve the goals

4.1. Phase 3: Ontology Modeling

The ontology modeling step is critical before beginning to build an ontology because it creates a map of concepts and gives a clear and proper vision of what is needed to be accomplished. Concepts are easier to convey graphically than in serialization format for the resource description framework/extensible markup language (RDF/XML). As a result, object-role modeling (ORM) was used to graphically represent the concepts. ORM began in the early 1970s as a semantic modeling method that observes the world in terms of objects fulfilling roles [11, 12]. ORM is a conceptual modeling language that imposes constraints on ideas that are very similar to OWL [13, 14]. As a result, this language is extremely versatile in terms of how it can be used and how well it integrates with OWL. Fig. 2 depicts a conceptual architecture for a GVT ontology.

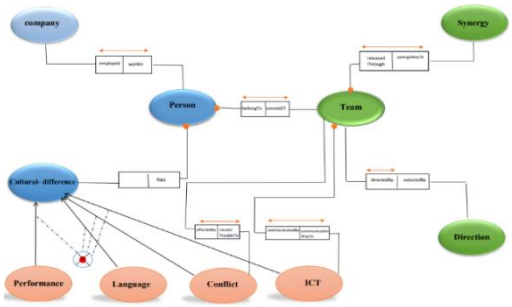

Fig. 2. Conceptual model of global virtual team ontology.

4.2. Phase 4: Ontology Implementation of The Global Virtual Team

Following the completion of the preceding phases, it was simple to begin the process of creating the ontology. In general, ontology is made up of ideas (classes) that are organized in a taxonomic hierarchy. These ideas (as in ORM) are connected by attributes, slots, or roles, and they contain instances [15]. The properties are subject to a set of constraints or limits known as facts or axioms. In general, three techniques exist for developing ontology in any field: manual ontology development [4], ontology teaching (learning) [16, 17], and ontology mapping. In the proposed ontology, manual ontology development was used, and it was then populated using the ontology mapping technique. The web ontology language (OWL) was used by the protégé tool version 5.5. [18, 33] Eleven classes were created to represent the proposed ontology, including six basic classes and four sub-classes. The cultural difference class was divided into four sub-classes: ICT (such as e-mail), performance (such as training), language (such as good listening), and conflict (such as misunderstanding). These classes were represented using the OWL language, which is a key component of the Semantic Web [19]. There are several approaches to developing a concept taxonomy, including top-down, bottom-up, and middle-out. As illustrated in Figure 3, the top-down strategy in the suggested ontology was used. The property was separated into three types in the OWL language [20]. The first was the object property, which is a link between two classes' instances (individuals). Property in OWL is similar to property in ORM, although property in OWL may not contain a range or domain. The data property is the second property that involves a relationship between instances (individuals) of classes and literals (values). The third property is represented by an annotation, which is a feature that allows one to add text to a document (metadata). As a result, 13 object properties (see Fig. 4) and 7 data properties (see Fig. 5) were proposed in this ontology.

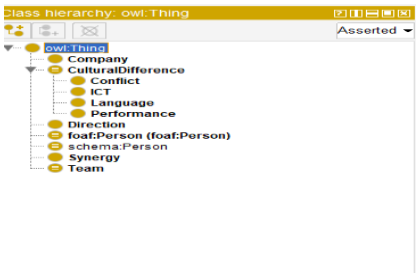

Fig. 3. Taxonomy of global virtual team class in protégé.

Fig. 4. Global Virtual Team object properties.

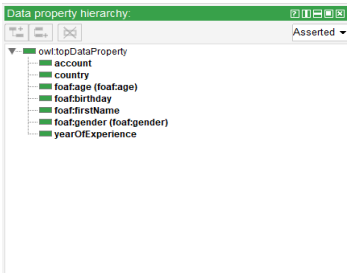

Fig. 5. Global virtual team data properties.

The proposed ontology is centered on the person class, the team class, the company class, the cultural difference class (which includes sub-classes such as the ICT class, the performance class, the language class, and the conflict class), the synergy class (how team members interact with the team), and the direction class (the direction in which the team is directed). The proposed ontology dealt with information about people such as names, ages, genders, date of birth, country (because the concept of a GVT includes individuals from various countries), years of experience, and accounts. Also included are the ICT class (means of communication among team members such as e-mail, face-to-face, zoom meeting, team viewer, Skype, Microsoft teams, Google meet) and the performance class (certificates obtained, reasons for conflict between team members). The reasoner included with the protégé editor was used to check and assess the suggested ontology implementation after it was completed. Then, the population stage of the ontology was completed. Ontology population refers to the process of populating an ontology with its inhabitants. Its mapping was used to create the ontology. Mapping Master and the DSL language were used to add individuals, their classes, and data type property values to the ontology.Mapping Master is a domain-specific language (DSL) for mapping spreadsheet material to ontologies.[21] The Manchester OWL Syntax, which is an OWL DSL in and of itself, serves as the foundation for this language (an ontology description language). Mapping Master adds a new reference clause that links spreadsheet data to it. Any OWL-named class, person, data type, or literal declaration in an OWL Manchester Syntax expression can be replaced with this defined clause. Individuals with their classes and data type properties were added to the ontology using the Mapping Master DSL, as shown in Figure 6. The symbol, "@" denotes any cell in a spreadsheet, such as "@A2", "@B2", "@C2", and so on. It refers to cells A2, B2, C2, and so on, adding their content to the ontology. The ontology was then tested and evaluated using the SPARQL query language by asking a series of competency questions, to which the ontology successfully responded.

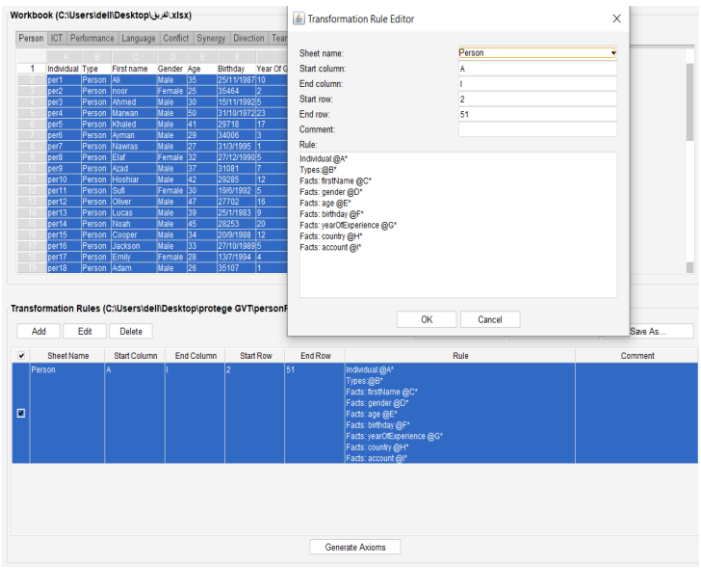

Fig. 6. Mapping master (DSL) in order to populate the ontology.

5. Results and Discussion

Fig. 7 shows a specimen of an individual from the GVT ontology after being represented in OWL. Similarly, Figure 8 shows the ontology graph of the person class after it has been represented in OWL language with a protégé, while Figure 9 highlights the ontology graph of the team class. SPARQL query results for testing and evaluating the GVT ontology are presented in Fig. 10.

6. Conclusion

The findings of this study reveal that the GVT ontology designed contains 11 classes, 13 object properties, 7 data-type properties, and 101 individuals and is regarded as the first ontology to show an interest in GVT in general. In addition to graphically modeling the concepts with ORM, Excel was used to tabulate the data, and it now serves as a shorthand and store for the ontology's components. To populate the ontology, the ontology mapping approach was used, which involved converting Excel sheets to OWL using the Mapping Master DSL technique. As a result of this technique, the ontology can be offered to a large number of individuals, as well as the ability to automatically add new classes and individuals to the ontology from Excel sheets. Finally, the proposed ontology was tested and evaluated using the SPARQL query language, with the ontology answering all competency questions correctly. The future work will include expanding the GVT ontology and incorporating it into a semantic information search and retrieval application.

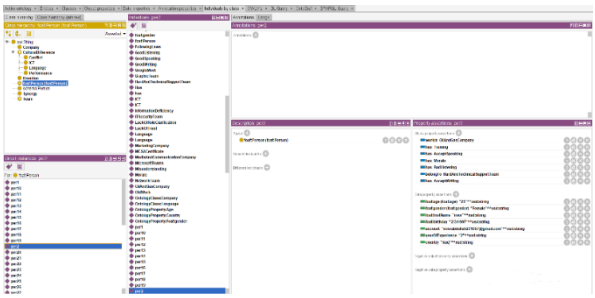

Fig. 7. Sample of individuals in Global Virtual Team ontology after supported in protégé.

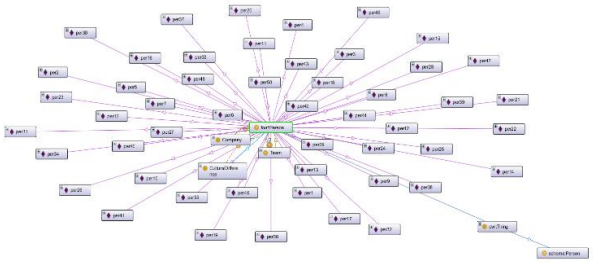

Fig. 8. Ontology graph of person class.

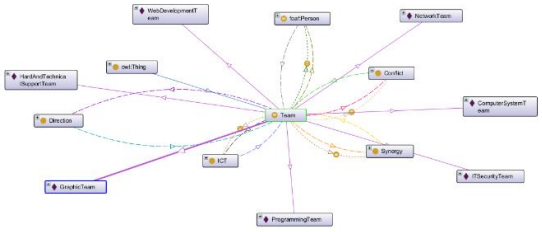

Fig. 9. Ontology graph of team class.

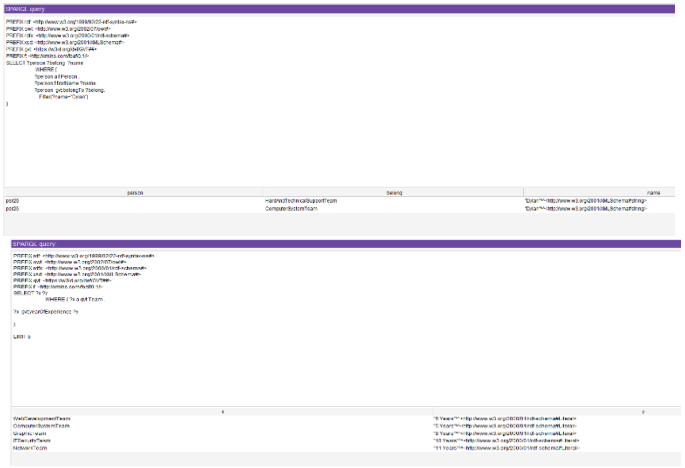

Fig. 10. SPARQL queries to test global virtual team ontology.

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تصميم نموذج تدفق المعرفة القائم على علم الوجود لتطوير أداء الفريق الافتراضي العالمي (GVT)

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معلومات البحث

الاستلام ٨ نيسان ٢٠٢٢
القبول ٦ أيار ٢٠٢٢
النشر ٣١ تموز ٢٠٢٢

الكلمات المفتاحية

فريق افتراضي عالمي ، أداء GVT ، علم الوجود ، ORM، OWL،استعلام سباركل.

الملخص

نمت شعبية الفرق الافتراضية العالمية (GVTs) نتيجة لزيادة العولمة والتقدم في تقنيات الاتصال . تلعب GVTs دورا متزايد الأهمية . لا يعرف سوى القليل عن استراتيجيتها او ديناميكياتها او فعاليتها في المنظمات العالمية . ركز العديد من الباحثين على الفرق الافتراضية ولكنهم لم يدعموا تقنيات البحث الدلالي وقدرة معرفة GVT على ان يفهمها الأشخاص وأجهزة الكمبيوتر . لذالك هدفت الدراسة الى بناء نموذج تدفق معرفة قائم على الانطولوجيا لتحسين أداء GVT تم استخدام تقنية Mapping Master الخاصة بالمجال (Mapping Master DSL) لبناء الانطولوجيا. يتيح انشاء وربط المفاهيم والافراد بالانطولوجيا باستخدام أوراق Excel تم بناء الاطار المفاهيمي باستخدام لغة نمذجة دورالكائن (ORM). تم استخدام استعلام سباركل لاختبار وتقييم الانطولوجيا المقترحة .

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