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InfOnto

An ontology for fashion influencer marketing based on Instagram

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Abstract*— The present applied research attempts to design an ontology of fashion influencer marketing domain based on fashion marketing resources in Iran that were available during the years 2014-2021. To extract concepts, relationships, and properties with inspiration from the knowledge engineering method proposed by Na and Neoh's study, Delphi and Domain Analysis approach was used in 3815 influencers' selection reason documents. To construct the ontology, a combination of The NeOn Methodology and Ontology Development 101, and Protégé (5.5.0 edition), were used. Ultimately, InfOnto was created with 1 conceptual core, 3 main concepts, 81 concepts, 8 categories, 2373 axioms, 1196 logical axioms, 61 object properties, 72 data properties, and 9 annotative properties. Concepts were evaluated using the Delphi method through interviews and questionnaires with 12 experts. In addition to the full supervision of the experts in all stages of the design and construction of the ontology, 30% of the defined concepts and relations were randomly provided to the experts for testing and approval based on their opinion

Keywords*— Semantic Web; conceptual modeling; ontology; InfOnto; fashion; influencer; influencer marketing; social media

I. INTRODUCTION

Social media and online search engines are two significant phenomena that have emerged thanks to the dramatic development of the Internet [1]. Social networks have an important role in the large-scale dissemination of information, ideas, rumors, innovations, and the like [2]. They have turned into a breeding ground for influencers and digital marketing. On social media, influencers are impactful content creators; ordinary or celebrity users who wield influence over opinions, purchase decisions, and politics. Their emergence has resulted in the growth of influencer marketing [3].

An ontology represents, formally names, and defines categories, properties, and relations among data, concepts, and entities substantiating one, several or all discourse domains. Ontologies are created by each field to minimize complexity and organize information into knowledge and data [4]. The acceptance of the semantic web by different sciences, along with information systems, and the organization of domain knowledge with semantic tools such as ontologies and meaning-based processing have created new opportunities for exploring and retrieving information and has provided the possibility of domain knowledge analysis by modeling concepts related to a domain. The multifaceted domain of fashion has a substantial role in world economy [4, 5], involving a sprawling chain of clothing design, manufacturing, and sales. It has various properties, and its behavior is not like other domains [4]. The fusion of fashion and family concepts, as well as its effect on lifestyle trends, and its being interwoven with many aspects such as ethics, culture, cultural groupings, psychology, art, literature, and popularity, highlight the emphasis society places on this area and all its aspects.

What drives fashion above all is individuals' need for belonging and sharing common opinions or thoughts [4]. Therefore, the intelligent introduction of fashion products is essential. When the sense of belonging is the backbone of the fashion influencer marketing field, new conceptual meanings are raised from the intersection of components such as behavior, perspective, and their commentary in the virtual community. Therefore, in addition to the effective interaction of influencers with other users in the social network and their harmony with the business image, their lifestyles and appearances are very important in their selection as product representatives. Currently, the effective selection process is done manually by experts in influencer marketing and fashion. In the influential field of fashion in Iran, no attempt has been made to compile knowledge organization tools such as a specialized thesaurus, nor has there been any attempt at encompassing conceptual knowledge. The interdisciplinary identity of the field of fashion and its massive semantic realms require that the design of the influencer ontology begins in a specific area, such as fashion on Instagram, with the formalization, clarification, and standardization of the conceptual modeling of the field's knowledge. The advantage of such an ontology is the formation of a strategic document in the policymaking and planning of semantic knowledge and conceptual modeling of the field. Additionally, it will be an effective and valuable tool for semantic storage and retrieval in specialized information centers, research organizations, and educational centers. Considering the expandable nature of the ontology, the arena will be proper to define the conceptual modeling in other social media where the topic of the effective selection of the influencer is tied to its literature.

In light of the above premises, this research seeks to answer the question: "What would be the most effective ontology of Influencers by determining the conceptual structure and

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semantic relationships extracted from information sources in the field of fashion in Iran?"

The rest of the paper is organized as follows; In II a brief overview of related literature is given. The methods of investigation, discovery, and extraction of concepts are given in III, and the implementation and maintenance of the ontology are discussed in IV. In V the paper is concluded and in VI ideas have been proposed for future work in the field.

II. Related Literature

A. Fashion and Ontology

In subject ontology, domain conceptualization is a discipline where concepts are symbols of topics belonging to the desired domain and are related to each other through specific relationships. This type of ontology can activate the semantic formation of the field and the search for its resources. Until 2021, 11 studies had been conducted in the field of fashion based on ontology, which are summarized in Table I.

TABLE I. Use of Ontology in fashion domain

	Details of study						**Ontology used**				
	Aim	***Dataset***	***Method/tool***	***Creation tool***	***concepts***	***output***	***Label***	***Modular***	***Scope***	***CA[b]***	***SA[c]***
[6]	Ontologies for virtual garment	Garment databases of rather small sizes	-	OWL	-	virtual garment	EN?	Yes	POC[a]	No	Very partially
[7]	eBIZ-TCF	-	-	KEI framework	-	ONTOMODA	EN	Yes	POC	Yes	Yes
[8]	Creating a platform for customization in the field of European fashion	Collected by experts	-	-	-	SFO	No	No	POC	No	Partially
[9]	Development of an ontology by NLP	Collected by experts	Stanford parser, Stanford POS tagger, WordNet	-	7	15000 RDF concepts	EN	-	POC	No	Partially
[10]	Providing a measure to evaluate the semantic similarity of the ontologies	-	DBPedia	-	17	DN measure	En	-	Large	No	No
[11]	A complete modular ontology in French	Experts, SFO and ONTOMODA	METHONTOLOGY	OWL 2.0 with Protégé 4.2	4980	VetiVoc	EN, FR	Yes	Very large	No	Partially
[12]	Largescale Fashion Recognition without any kind of image annotation.	Fashion60	-	-	-	HDL algorithm	EN	-	Large	No	Very Partially
[13]	Create Fashion Segmentation Dataset	50K clothing images in daily life	-	-	46	Fashionpedia ontology and fashion segmentation dataset	En	Yes	Very	No	Very Partially
[14]	Create a Chatbot	5000 pairs of Q/A of top-10 clothing brands of Pakistan	VOWL, OntoGraf, SPARQL	Protégé	18	The AI Chatbots	En?	-	POC	No	No
[4]	An Ontology-Driven Fashion Recommender System	-	PHP, HTML, CSS, JavaScript	Protégé	7	-	EN?	-	POC	No	No
[15]	Comprehensive recommender system under Windows	-	-	-	-	-	EN?	-	-	-	-
[16]	novel algorithm for hierarchical fashion recognition	DeepFashion	-	-	-	IA, GA, TOP1, and TOP3 algorithms	EN	-	Large	No	Very Partially

[a] A proof of concept (POC)

[b] *Content available*

[c] *Structure available*

A model that abstractly describes 1) a human body (e.g., neck, torso, arm, and leg), 2) fabric patterns, and 3) clothes (e.g., dresses, trousers, jackets, and skirts) is modelled by Fuhrmann et al. [6]. The dressing process can be specified and controlled on a higher semantic level based on this ontology and extensions to clothing. It is shown how the semantic information can be used to enhance the collision detection process. An ontology devoted to the textile and garment profession, called ONTOMODA, was presented in a 2009 paper by Sabbata et al. [7]. Its main purpose modelling a portion of said sector knowledge by semantically describing its several aspects. It allows for the standardization, readability and integrity of the documents that are exchanged among various industry players via XML schema brackets annotations. As a modular ontology, it is organized in three levels, namely 1) a top-ontology ConceptModelOntology, 2) a set of modules that organize a core ontology, and 3) a module OntoMODA as a domain ontology. In 2012, Vogiatzis et al. [8] presented a monolithic ontology called Servive Fashion Ontology (SFO) that provided a unified structured vocabulary representing fashion, human and manufacturing concepts. It shares many common concepts and terms with those domains, and human experts were responsible for this part of the SFO. It is not modular, consists of nine main classes, and its modeling is very meticulous and comprehensive. In their 2013 paper, Novalija et al. [9] presented an approach to creating domain ontology by applying NLP techniques, based on user-provided concept seeds for a specific domain, which includes 4 phases, 1) Collection and definition of concept seeds, 2) Mapping seeds to Wikipedia, and extending the ontology with relevant related concepts, 3) Definition of relationships between concepts, and 4) Ontology refinement. A 2016 paper by Kalkowski et al. [10] proposed a custom fashion ontology and several similarity measures. According to this, the feature-based measure, Direct Neighbors (DN), achieved the highest correlation with human judgment, which makes use of the semantic information stored in the ontologies to compute the similarities of sets of terms. A 2016 paper by Xaviera et al. [11] presented a modular French termino-ontological dedicated to the different Fashion, Textile, and Clothing (FTC) fields, from head to tail, named VETIVOC, which was created within the Protégé 4.2 (OWL 2.0) framework, and used ONTOMODA-ML, SFO and FTC ontologies as ontological resources. VETIVOC is an industrial project that aims to provide a resource in French, and more importantly to cover the different FTC fields, by combining 1) the knowledge of several experts on FTC domains and 2) the terminologist knowledge on these domains, from users to eCommerce websites via manufacturers. An automated approach to large-scale fashion recognition was proposed in a 2018 paper by Kuang et al. [12] based on their new hierarchical deep learning (HDL) algorithm. It provides an image without any sort of annotation by integrating the two-layer concept ontology in order to explicitly separate the interrelated tasks, via learning the more discriminative tree classifier and several deep networks together in an end-to-end manner. A 2019 Paper by Jia et al. [13] presented Fashionpedia with the aim of training and benchmarking the computer vision models for a more comprehensive understanding of fashion through the creation of a high-quality opensource fashion-relevant dataset. The Fashionpedia includes 2 parts: 1) an ontology built by fashion experts, and 2) a fashion segmentation dataset built upon the backbone of the Fashionpedia ontology structure. A 2019 Paper by Jia et al. [14] presented an ontology-driven AI chatbot for fashion brands, on the handwrought set of 5000 Question-Answering of top-10 brands of Pakistan in the fashion domain, which covers information such as new arrivals, sales, packages, return policies, etc.A 2020 Paper by Usip et al. [4] aiming at designing an ontology-based garment recommender system for users for a specific occasion based on their preferences, presented an ontology-based framework for creating a complementary outfit after analyzing and evaluating existing mobile fashion applications. The fashion ontology was created within Protégé, and the recommender web application used PHP, HTML, CSS, and JavaScript technologies. According to a 2021 patent by Ananthanarayana et al. [15] with the aim of developing a Windows-based intelligent system that provides fashion advice information in a consumer-friendly manner, presented an idea based on Computer vision methods, and a system of universal fashion ontology, fashion rating, and recommendation. A 2021 Paper by Kuang et al. [16] presented IA, GA, TOP1, and TOP3 algorithms for hierarchical fashion recognition by embedding the ontology of their previous study [12] into deep networks to learn tree classifiers and deep networks jointly in an end-to-end fashion. They develop a novel AHDL approach and present a more user-friendly interface for path-based fashion recommendations.

B. Influence Maximization Problem

Choosing proper influencers is extensively studied through the Influence Maximization (IM) Problem, which has widespread importance in viral digital marketing. Through the identification of appropriate influencers, IM seeks to maximize influence. IM is an active area of research in the computational social network analysis domain. because of the potential applications of this problem in different domains, the problem has been studied for over one and half decades [3]. In terms of theoretical performance, the IM algorithms have continued to grow, and studies have matured. The latest research was more focused on making IM more realistic through studying various factors [1], such as IM on multiple social networks [3], indirect influence [18], campaign feedback [19, 20], sentiment [21], topic similarity [22], etc. but not very practical in the real world yet [1].

No research, neither in Iran nor elsewhere, has centered on the design of ontology in the Fashion Influencer Domain. Identifying the basic concepts and the relationships between them from the knowledge sources of the field, and designing the ontology are the concerns and main target of this study, which distinguishes it from other backgrounds.

III. RESEARCH METHODOLOGY

This research is practical in terms of purpose, and uses the qualitative method of Domain Analysis, which is used in

ontology development. The required data were obtained from information sources in the field of marketing, which were in the archives of 7 brands and 4 stores selling local brands from 2004 to November 21, 2021.

The Delphi approach has been used to confirm the concepts, categories, subcategories, their obtained relationships, and validation of the ontology. The knowledge engineering approach presented by Na and Neoh in [23] was the inspiration in the extraction of the concepts and semantic relationships between them.

The topics, concepts, and terms extracted had to be identified based on collective wisdom due to their semantic complexity, as well as for standardization; Therefore, the Delphi approach was used to reach the richest concepts, confirm the obtained categories, and finally confirm the ontology. The Delphi approach is a systematic method in research that is carried out in the form of the participation of experts in the research topic, and the validity of the research depends on the competent selection of these people.

The current research population was obtained from two explicit and implicit sources: A- Explicit sources, which were taken from the statistical population of influencer selection of product introducers in Iran from 2004 to 2021, including 3815 marketing documents belonging to 9 groups active in the Iranian fashion industry, and according to the study of the entire statistical population, there was no need for sampling. B- Non-explicit sources, including experts' opinions, which were made available through interviews and questionnaires.

The Delphi panel members were 12 subject experts with opinions in the field of influencer marketing and fashion. Opinion was obtained through several online meetings and interviews and two stages of questionnaires. The members were involved with the research from the beginning of the work to reaching the content-oriented patterns, ontology architecture, and evaluation.

The primary tool used to survey the experts was an interview and an online meeting, followed by a questionnaire. The 5-Point Likert Scale was used to measure the total conceptual indicators in the first and second rounds. At the end of the indicators related to each component, a space was considered to add the experts' opinions. The status of answers was described by determining the average. All the information obtained in Excel was modeled by categorizing it in terms of concept, category, subcategory, and sub-concept using Visio software, Fig. 1.

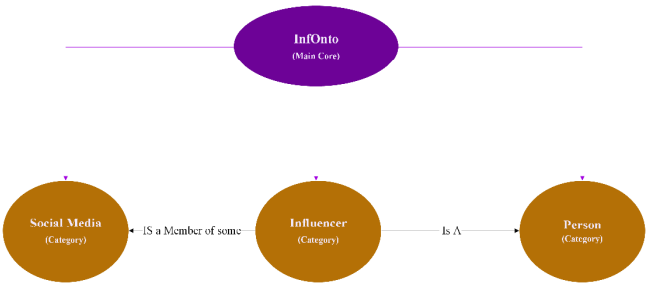

Fig. 1. *Example of modeling in VISIO*

To build the ontology, a combination of The NeOn Methodology and Ontology development 101 was applied the 7 stages of the 101 were placed in the form of scenarios 6 and 8 and the iterative-incremental model of Neon. And from the 3 methods for the development of ontologies, namely top-down, bottom-up, and combined development, the latter (in the form of supercategory-subcategory and subcategory-supercategory structure) was utilized by creating an informal taxonomy, including words, Micro and macro concepts. Then it was placed in a hierarchical structure with a systematic survey of experts, which is usually a comprehensive and top-down process.

A. Ontology Development 101

The 101 was proposed by Noy and McGuinness based on the idea that there is no one solution to model a domain. Choosing the best template among the available options depends on the expected usage. To develop an ontology that best reflects the real world, one must evaluate the ontology in its intended application, which often leads to corrections. As a result, ontology development can be considered a recursive process. This method suggests 7 steps: 1) determining the domain and scope; 2) review of existing ontologies for reuse; 3) enumerating important terms; 4) defining classes and class hierarchies in a modeling tool; 5) defining the slots of each class; 6) defining the facets of slots, and 7) creating instances [24].

B. The NeOn Methodology

The NeOn was presented by Suárez-Figueroa in 2010 based on DILIGENT, OTKM, and METHONTOLOGY methods [25] and has four main parts:

1) Glossary of processes and activities that the people involved in the project do not get confused about.

2) Ontology building scenarios: based on the experiences gained from several projects, 3 different ontology building situations (single ontology, collection of individual ontologies in interaction, and ontology networks) are defined. As result, 9 different scenarios have been introduced for the construction of an ontology, with special emphasis on the re-use of existing ontological resources and re-engineering.

3) Two ontology network life cycle models.

4) A set of methodological guidelines for carrying out processes and activities.

IV. Implementation and Maintenance

Building an ontology requires gaining implicit knowledge from the texts and explanations of experts who have deep knowledge of the domain. The importance of using ontology in information retrieval systems has led it to be used as one of the most effective semantic tools for modeling concepts in various subjects. The first step is to determine the domain and scope and specify the end users. The scope of the ontology of influencer marketing concepts is specific to the fashion industry and the relationships between them. The "InfOnto" was specially designed and

implemented to be used in the "fashion influencer recommendation system", and the researchers and information specialists who oversee indexing and accessibility of the information resources of the influencer field are also the end users of this ontology. In the second stage, after realizing the absence of an ontology in the influencer field, the InfOnto was designed from scratch through reusing and re-engineering existing ontological resources.

A. Enumeration of important terms

The manual extraction of field concepts and their relationships among them was done in 4 distinct stages and 354 objectives, and implicit concepts were drawn from the statistical population of about 3815 marketing documents detailing why influencers were chosen to advertise different products belonging to 11 active fashion producers and retailers in the Iranian fashion industry.

The first step was to read the existing and recorded documents and extract the main terms of the reason for influencer selection separately.

After that, while following the strategies related to the scope of knowledge, the Domain analysis was performed. In this stage, the linguistic pre-processing of the concepts was formed, its purpose being to determine the exact position of the concept, category, subcategory, and sub-concept. The Domain analysis of the field is focused on the importance of subject knowledge and its surrounding, and it is necessary to identify the ontological, epistemological, and sociological dimensions of the field, which is why, in order to formalize the concepts in a natural language, in addition to considering the standards, there is a need for consulting with groups of subject matter experts known as meta-knowledge; Therefore, after consulting the standards, all concepts were divided into three conceptual categories in order of frequency. This stage was evaluated to correctly identify the findings, using the Delphi approach.

The third, a survey of the experts through online meetings and interviews led "influencer selection reasons" to be agreed upon as the core concept. Then, following a vote by experts, 3 conceptual categories were selected: "influencer", "person" and "social media".

The fourth stage was a survey with a questionnaire to determine and confirm the categories and subcategories. The position of the categories and subcategories extracted from the knowledge sources in each conceptual category was ranked and determined with the agreement of the experts, and at the same time, the categories and concepts suggested by them were added. The final term information worksheet was completed as in Table II. Finally, with the agreement of Delphi experts, a conceptual core, 3 general concepts, 8 categories, 24 subcategories, and 179 subconcepts were introduced for ontology design. The categories and subcategories of the 3 main concepts are:

Person - includes 3 main categories: 1) physical characteristics with 11 subcategories, 2) identity with 10 subcategories and 3) lifestyle with 15 subcategories.

Social media - including three main categories: 1) Account with 8 subcategories, 2) Feature with 12 subcategories and 3) Output with 7 subcategories.

Influencer – includes a subset of Person and Social media.

TABLE II. THE TERMS INFORMATION WORKSHEET SAMPLE FOR THE "NAME" CONCEPT

Concept	نام تاثیرگذار	***In English***	Inflluencer Name
Abbreviation	-	***Definition***	Includes first name, last name and alias.
Synonym	Full name, Given name, Alias, First name, Family name	***Semantic relations***	introduces a person/ Every person must have a name/ Every person has at least one last name that was given to them at the time of birth/ Each person can have one or more alias
Domain	Person	***Range***	Text
Available Ontological resource	https://dbpedia.org/ontology/Name (owl:Class) https://dbpedia.org/ontology/Surname (owl:Class) https://dbpedia.org/ontology/GivenName (owl:Class) https://www.wikidata.org/wiki/Q82799 https://dbpedia.org/ontology/alias (rdf:Property) https://www.wikidata.org/wiki/Property:P742		

In addition to hierarchical classes, non-hierarchical properties were also extracted from the information worksheet, and 61 object properties, 72 data properties, and 9 annotation properties were applied. Fig. 2 shows some of the object properties used in InfOnto. Examples include "is influence on"; "Is a member of" and "has value".

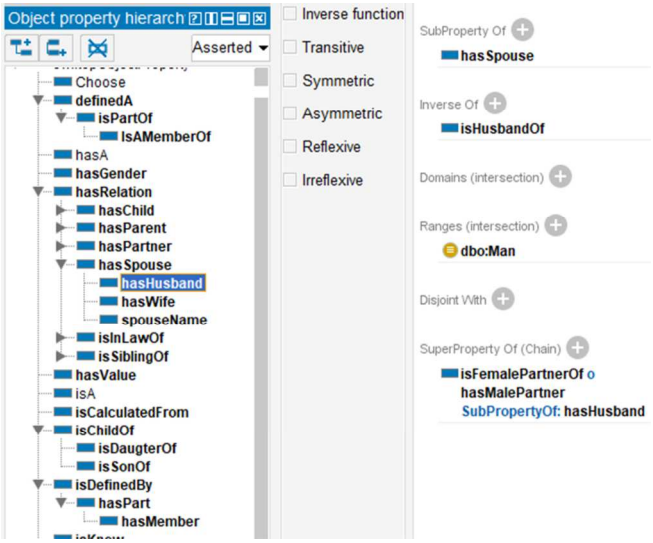

Fig. 2. *InfOnto ontology object properties*

B. Implementation

InfOnto has been constructed in Protégé (version 5.5) and in OWL2. This software has the ability to run, maintain, expand, update, edit and validate ontologies, and there is a

competent support and development team behind it. It was used to create the concepts and their relationships and characteristics; Therefore, by implementing the ontology and displaying it with graphic plugins, the research question"(i.e., What would be the most effective ontology of Influencer by determining the conceptual structure and semantic relationships extracted from information sources in the field of fashion in Iran) was answered. Fig. 3 shows the main metrics of the ontology.

Ontology metrics:

Metrics

Axiom	2373
Logical axiom count	1196
Declaration axioms count	896
Class count	81
Object property count	61
Data property count	72
Individual count	671
Annotation Property count	12

Fig. 3. *The main metrics of InfOnto ontology*

To have a graphic representation of the superclass, category and subcategory, and relationships in the ontology, there are many possibilities available in Protégé. The most expressive display is possible with OntoGraf and WebVOWLl plugins. Fig. 4 shows a part of the supercategory, category, and subcategory and the relationship defined for each one. The colored lines on the right represent the feature information between the classes.

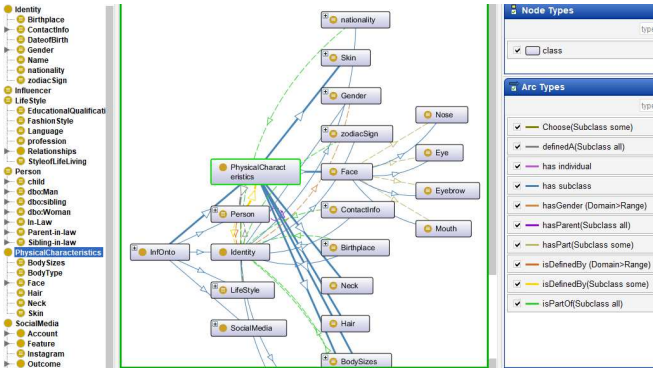

Fig. 4. *Part of the classes and subclasses and their relationships using the OntoGraf plugin*

Fig. 5 and Fig. 6 show a general representation of the conceptual structure of the InfOnto with the help of Ontograf and WebVOWLl plugins.

In addition to checking the validity, importance, and correctness of the concepts, this ontology proceeded under the full supervision of experts at all stages. In order to measure the coverage of the concepts, 30% of the selected concepts and the defined relationships were randomly provided to them for testing and confirmed based on their opinion. It was also evaluated and debugged with the help of OntoDebug and OWL Lint plugins.

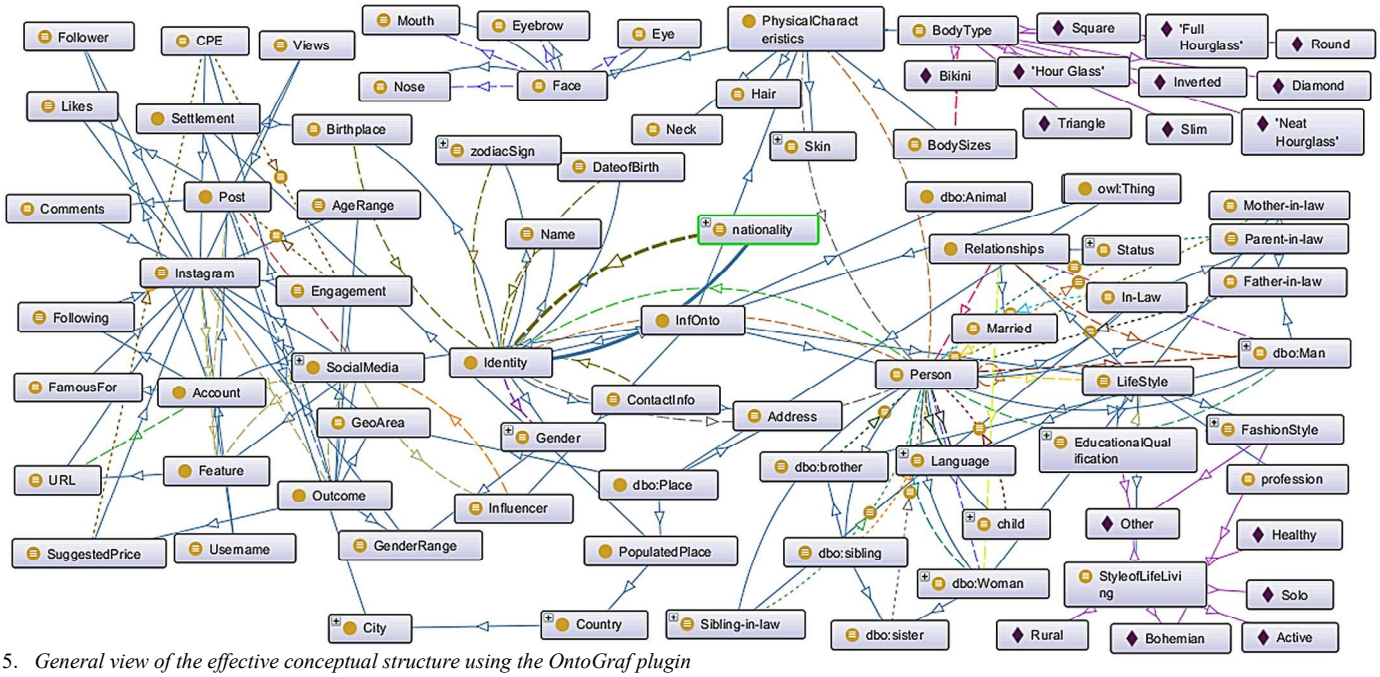

Fig. 5. *General view of the effective conceptual structure using the OntoGraf plugin*

V. Conclusion

The attention paid to the importance of fashion and clothing, and the impact of social media on today's life have made the latter the main place for providing and expanding trends in society. The influencer's role in social developments and the decisions made by members of society is tied to his personal and cultural values and its results have

a significant impact on all aspects of the decisions of the followers who have trusted him. Despite the new semantic topics and extensive knowledge of advertising in the fashion industry, which stems from the interdisciplinary nature of the field and the intersection of numerous topics in the field of social media influencers, no action has been taken to conceptually model it. By understanding the conceptual space of the field's knowledge texts and with the scientific agreement of the field's experts, this research has achieved the construction of the first example of an influencer field ontology, which represents its conceptual model, in the field of the fashion industry. Ontology is one of the important components of technology. It is a semantic model that provides the opportunity for a rich visual and informational environment by creating a conceptual model, and the result is helping to represent knowledge in the subject area. Deciding how this detailed operation will reach an effective, maintainable, and expandable result requires consulting myriad conceptual modeling research as well as the experience of experts in the field as meta-knowledge. The influencer ontology, called InfOnto, is a semantic tool in the subject domain of the fashion industry with a focus on women's fashion and in the field of marketing, carried out through Domain analysis using a Delphi panel and a survey of experts.

InfOnto is the first ontology in the field of “influencer”, so it is impossible to compare its concepts, relationships, and characteristics with another research. We expect its development to be a starting point for the formation of ontology in the field of effective marketing.

Among the limitations of the current research, we can point out the lack of referable subject literature in the field of ontological studies in the country, and the lack of cooperation among qualified experts in reviewing the findings and helping to fix the flaws and unifying the concepts and relationships between them.

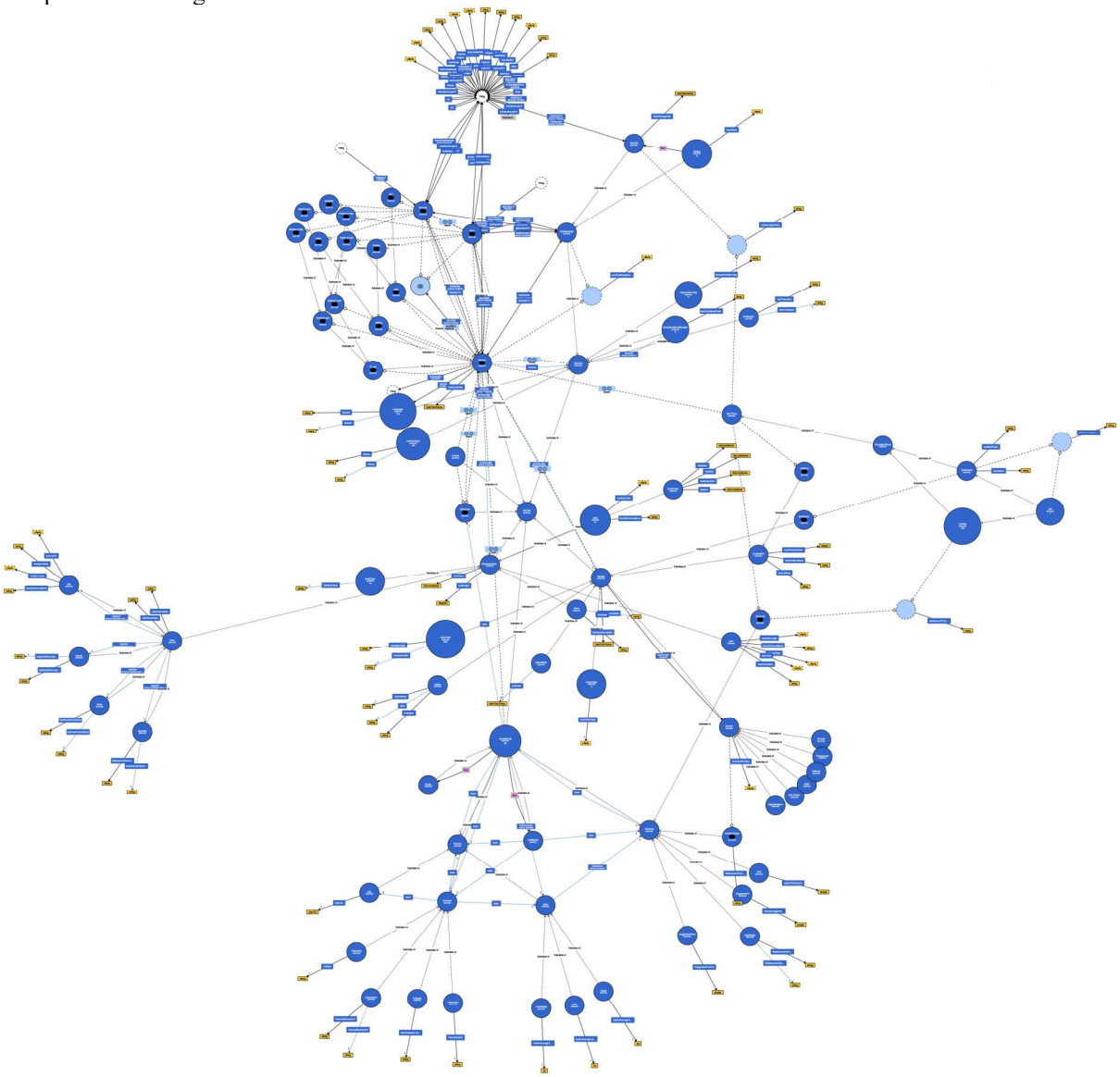

Fig. 6. *Overview of the conceptual structure (WebVOWLl)*

VI. Future work

InfOnto is effective as a strategic document in the field's conceptual modeling policies, and it will also be useful as a tool for effective semantic storage and retrieval in specialized centers and to facilitate the research interactions of the field's expert users. The artifact is designed to solve a practical problem, and its results can be considered as a guide for experts and help in research and studies in the field. Like similar projects, it can be used to strengthen and upgrade the main and sub-areas related to social media influencers, and, when used, can be evaluated by experts. It can be reused and edited during the creation of other applications or ontologies to get closer to optimal results.

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