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Research Article

Design of a trust system for e-commerce platforms based on quality dimensions for linked open datasets

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ABSTRACT

This article describes a proposal about a trust system for e-commerce platform based on semantic web technologies and trust dimensions rules. We try to expose a system that allow to manage communication processes between e-commerce platforms and users in a trustworthy manner. It allows the data flows and transactions gain more trust across the entire process. All of this can be achieved through the inference of rules exposed in the defined ontology, complemented by a cloud-based system with microservices architecture. With the implementation of the system through an e-commerce platform, could consume data from the microservices in order to get inferences about its clients that want to buy or sell something within its system. This system was created based on rules defined by the ontology, as well as the microservices could be used to register information about multiple e-commerce transactions. The result of this work is the Ontology and semantic web rules defined and implemented through protege.

Keywords: LOD, e-commerce, semantic web, microservices, trust dimensions, Web 3.0

INTRODUCTION

Through the contingencies presented in the Covid-19 pandemic, there was a great explosion in the use of platforms based on electronic commerce in all aspects. Businesses that still did not manage their transactions through the Internet have been forced to start Digital transformation processes. It is known that there are e-commerce platforms whose owner is a business that sells goods and wants to reach its customers directly (B2C), as well as other platforms that provide their service as a channel where their customers can be both sellers and buyers and provides an intermediary service between the two to carry out a transaction.

The growth that has been taking place on the Internet to carry out transactional processes involves a series of elements that allow the integration of strategies from security criteria associated with the exchange of data between clients and digital commerce, to measuring the levels of reputation that each one can handle. of these solutions. If added to these criteria, we associate the influence that the different channels and social media must expand coverage and visibility of these e-commerce strategies, a series of factors associated with the reputation levels of these channels must be considered, as well as of each of these trading platforms. Based on the security aspects, solutions based on single authentication are being established, such as those proposed in (Alabi, White, & Beloff, 2020), (Kuruwitaarachchi, Abeygunawardena, Rupasingha, & Udara, 2019), (Wang, Zhao, & Zhong, 2019), or (Mahmood, 2009; Arias-Caracas, 2018). However, the data that was generated in some electronic commerce establishments allows for another principle to determine its use and, within previously established trust criteria, can generate certain levels of reliability for the use of these transactional channels and facilitate purchase processes through digital platforms.

Based on this scenario, the growth of digital platforms based on e-commerce, and the new software application solutions available in the market, this article aims to present a proposal of a model in order to facilitate trust relationships between clients

and establishment through e-commerce platforms. The model proposed is through mechanisms based on principles of trust and open data for all transaction processes carried out on emerging platforms. This work used a quasi-experimental method in order to collect the different approaches of trust-based metrics for evaluation of web resources. Once we got the enough information and used a theoretical method of analysis and synthesis to propose an ontological model based on methontology (Gómez-Pérez, Fernández-López, & Corcho, 2006), the main ontological design methodology until now to perform the trust evaluation.

BACKGROUND

Linked Open Data (LOD), represent advantages in order to facilitate their reuse and carry out data consumption on several knowledge areas. From the public perspective, we can found proposals associated with e-government (Klímek, Kučera, Nečaský, & Chlapek, 2018) and (Ortiz-Rodriguez et al., 2022), within the tourism sector cases have been applied to facilitate the location of points of interest through georeferenced data (Lemus, Benavides, Gaona-García, Montenegro-Marín, & Garzón, 2020), (Yochum, Chang, Gu, & Zhu, 2020)), associated with education processes, scenarios have been identified to facilitate learning processes (Pereira, Siqueira, Nunes, & Dietze, 2018).

The base of the LOD is the semantic web proposed by (Berners-Lee et al., 2001) with the aim of give more meaning to the web with the usage of ontologies to describe the resources and relationships between them. In the e-commerce sector, there are proposals that use LOD concepts in order to obtain better relationships between client's and e-commerce platforms based on recommender systems (Peska & Vojtas, 2015) and (Tomeo, Fernández-Tobías, Di Noia, & Cantador, 2016), proposals that are presented as scenarios that promote interaction between clients and, in general, between stakeholders through the different electronic commerce platforms available in the market. However, to determine trust criteria, it is necessary to determine quality aspects associated with dataset that is shared openly, so that they can later be linked as solutions based on Linked Open Data (LOD). To determine these quality levels, this study is based on the work carried out by (Zaveri et al., 2013), who made a compendium of variables in order to evaluate the quality of LOD datasets by classifying 26 quality dimensions grouped into 5 dimensions as presented in the **Figure 1**. These aspects are presented in this study to determine trust criteria, it is necessary to determine quality aspects associated with the dataset that is shared openly, so that they can later be linked as solutions based on Linked Open Data (LOD).

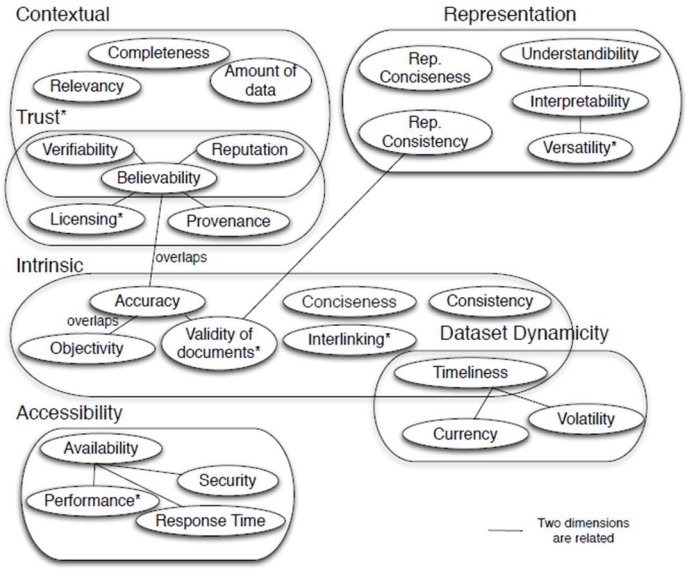

Figure 1. Linked data quality dimensions (Zaveri, y otros, 2013)

Trust dimensions are those that focus on the reliability or integrity of data sets. The five dimensions that confirm this group are:

- **Origin:** This dimension refers to the metadata to represent, manage and use information about the origin of the data. Metrics for provenance can be obtained by evaluating the metadata associated with the source.
- **Verifiability:** This dimension refers to the degree to which a data consumer can assess whether the data set is correct and therefore its integrity. It can be measured by a third party, if the data set is linked to the source or with the presence of a digital signature.
- **Reputation:** According It is a judgment made by a third party and that determines the integrity of an author, be it a person or an organization. The entity publishing the data must be identifiable by some means. It can be evaluated through community surveys or external links.
- **Credibility:** Degree to which the information is accepted as correct, real, true and credible.
- **Discharge:** This dimension guarantees the possibility of data reuse by a consumer. It can be measured through the description of reuse permissions.

All dimensions of trust are related to credibility, and if your metrics measure high, this implies that credibility is also high. In the following sections, the design and development of the model for the evaluation of these metrics applied to e-commerce will be presented together with the architecture of the platform, based on microservices.

DEFINITION OF CONCEPTUAL ARCHITECTURE OF THE PLATFORM

This study is experimental and proposes to deploy a modern architecture based on microservices to assert levels of trust on actors involved in transactions on E-commerce platforms. Exploration instruments were used, compiling bibliography referring to resource trust assessment models.

The components defined in the conceptual architecture of the platform are addressed in **Figure 2.**

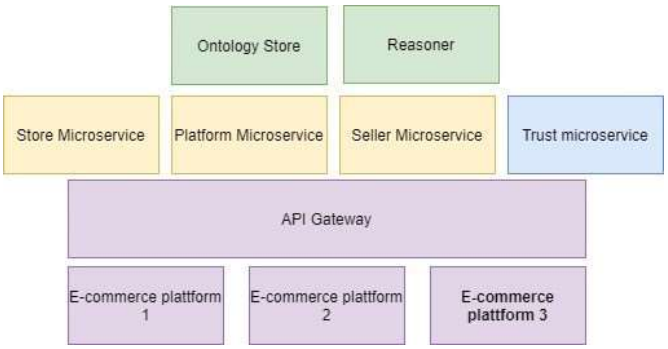

Figure 2. Proposed trust-based system architecture for E-commerce platforms (Author's ownership)

The **Figure 2.** corresponds to the proposed architecture in this work, each component includes the following aspects:

- An extension of the LOD resource query semantic model, for evaluating confidence levels on resources stored in a database for ontologies.
- A reasoner to evaluate semantic trust rules.
- A set of microservices for capturing the metrics associated with trust levels that eCommerce platforms can provide.
- A microservice for querying the levels of trust on the actors of the platforms.
- An API Gateway for the exposure of services in a secure way.

EVALUATION PROPOSAL OF TRUST DIMENSIONS APPLIED TO E-MARKETING

Based on the work of (Zaveri et al., 2013) as a reference, the dimensions, and metrics to work within the Ontology are described. Below, **Table 1** describes the most relevant.

Table 1. Proposed dimensions of trust (own author), based on trust dimensions collected adapted by (Zaveri et al., 2013)

Trust dimension	Description	Fitted Dimension	Metrics
Metadata about the dataset	Presence of title, content and URI of the dataset	Metadata about the E-commerce platform, URL, Name	Platform contains or does not contain metadata about the company
Calculation of the integrity/reliability of RDF statements	Using Trusted Annotation Provenance in Social Networks	Recommendations on the platform about social networks	Sentiment analysis model on social networks and comments on platforms (-1 Negative, 0 neutral, 1 positive)
Detect the reliability and credibility of the person who publishes	Calculating a confidence value between -1 (Absolute Distrust) and 1 (Absolute Confidence). Calculating trust based user rating methods or option based	Reliability of the person/company that publishes on the platform based on trust relationships with other platforms or users	
Verification of information of the person who publishes	Indicating the author, their contributors, the publisher of the data and their sources	Vendor Information Publication	FOAF, presence PersonalProfile Document
Authenticity verification of the data set	If the dataset uses provenance vocabulary		
Publisher Reputation	Survey in a community about others	Social media comments about sellers	
Dataset Reputation	Analyzing references in page rankings by assigning a reputation score to the data set	Trust levels assigned on different platforms	
Credibility or Meta-information about the identity of the information provider	check if the provider/contributor is contained in a list of trusted providers	List generation of trusted platforms, sellers, buyers	
Indication of license in understandable format for machines	Detection of license indication in the voiD description	Presence of terms and conditions associated with the protection of personal data in a format understandable by machines	

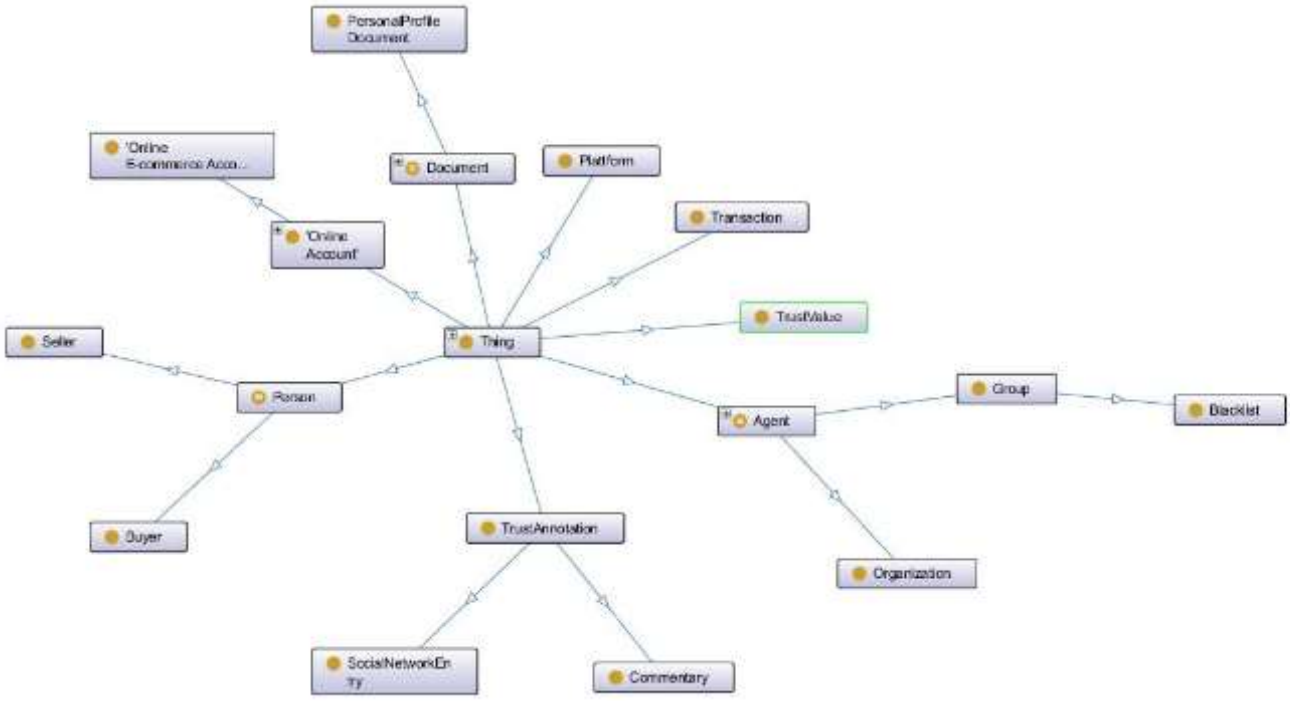

Figure 3. Adhoc taxonomy of concepts generated from OntoGraph plugin for Software Protégé created for this work (Author's ownership)

Based on these criteria, the design and implementation of the model is defined below, based on the integration of linked data and ontologies to carry out transactions through platforms.

DESIGN AND IMPLEMENTATION

For the design of Trust Evaluation Ontology in e-Commerce platforms, the Methontology methodology was partially applied (Gómez-Pérez et al., 2006), despite the fact that the methodology has around 20 years of development, it is still valid and is widely used in the design of ontologies in the present day by its completeness and has been accepted in other areas of applications (Riaño et al., 2022; Ortiz-Rodriguez et al., 2022; Valencia et al., 2017) and given its specificity, it allows the complete development and documentation of the developed Ontology. The document describes the artifacts generated from the application of the methodology. Some of these specifications for its construction are described below.

Taxonomy of concepts

An extension of the FOAF Ontology was made that contains entities that can support some trust rules defined from the compilation of (Zaveri, y otros, 2013). New entities and relationships were added to support the rules that were not covered by FOAF as evidenced in **Figure 3.**

Figure 3 shows the taxonomy concept graph, generated from the OntoGraph plugin of the Protégé Ontology editing tool. We can interpret the graph like classes and subclasses relationship. Each box represents a class and each edge the relation between two concepts.

Binary relationships between concepts, description

The **Table 2** shows the relationships between concepts added to the Ontology to support the trust model. The tables are built from the indications of the methodology used.

The **Table 2** was build identifying and listing the concepts required, the relationships between them and some specifications of that relationship.

Attributes

The **Table 3** describes the general attributes defined for each concept:

The **Table 3** was built describing the attributes of the defined entities.

Description of Formal Axioms

Formal axioms were defined to support the defined confidence dimensions, where for each dimension there is an axiom that allows calculating the defined metric, then the **Table 4** exposes the most representative.

Table 2. Relations between concepts (own authorship) based on the task 5 defined by methontology (Gómez-Pérez, Fernández-López, & Corcho, 2006)

Concept of origin	Name of the Relationship	Inverse relationship	destination concept	Cardinality
Person	performs	IsPerformedBy	Transaction	1-n
Platform	supports	isSupportedBy	Transaction	1-n
TrustAnnotation	isWrittenBy	Writes	Person	n-1
TrustAnnotation	isQualifiedBy	Qualifies	TrustValue	1-1
BlackList	contains	isContainedIn	Person	1-n
Organization	provides	isProvidedBy	Platform	1-n
Platform	register	isRegisteredIn	Person	n-n
Platform	belongsTo	Have	Organization	n-1
Platform	Certificate	certifiedBy	Person	n-n
TrustAnnotation	talksAbout	isMentionedIn	Person	1-n
Buyer	buysFrom	sellsTo	Seller	n-n

Table 3. General attributes concepts (Author's ownership) based on the task 7 defined by methontology (Gómez-Pérez, Fernández-López, & Corcho, 2006)

Class attributes	Name of Concept	Type of Value	Cardinality	Values
trustworthy	Person Platform	Boolean	(1.1)	True,False
name	Platform	String	(1.1)	Name of platform
certificateTrust	Platform	Boolean	(1.1)	True,False
webAppUrl	Platform	String	(1.1)	URL of Platform
value	TrustValue	Float	(1.1)	0-1

Table 4. Definition formal axioms (own author)

Confidence Dimension Adjusted	Axiom Name	Description	Expression	Concepts	Attributes/ Relationships
Metadata about the E-commerce platform, URL, Name	Trusted platform metadata	Expression that validates the presence of trusted attributes on the platform	Contains, Name, URL, Organization	Platform Organization	supports
Recommendations on the platform about social networks	Trusted platform	Expression that validates if a platform is trusted	TrustValue > 0.5	Platform TrustValue	Trust
Confidence level for people who have carried out transactions with the entity or actor (Buyer Seller)	transactional trust	Relationship between users who have carried out transactions on any platform	If user A transacted with user B and user B with user C, User B transfers the trust value on C to User A	Person transaction	Performs TrustValue
Use Ontologies like FOAF to assign trust values to users	Total User Confidence Value	The confidence value calculated through the other rules	total trust = average of legacy trust, transactional	TrustValue Person	Trust

ANALYSIS OF RESULTS

Through the methontology methodology, ontologies can be developed or extended with rules capable of inferring knowledge for a particular area. In the case of this article, it is possible to map trust metrics for LOD resources to an ontology (eCTEO) with rules that allow evaluating the trust levels of the different actors of E-commerce platforms that are used in transactions in the tourism sector and that are integrated into a cloud native platform (eCTEP), based on microservices, which uses artificial intelligence services to complement the Ontology, calculating metrics associated with natural language processing.

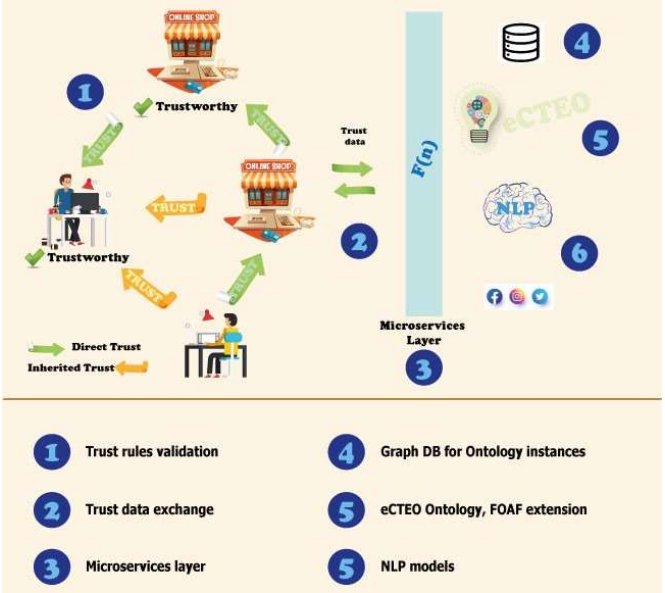

Figure 4. Proposed model

The **Figure 4** describes the semantic platform model for establishing and validating trust rules to evaluate users across different platforms. The listed components cover:

Establishment of rules for assigning and transferring trust values inferred by the ontology.

- I exchange information with the platform to load information on trust metrics.
- Microservices consumption queries direct/Hereditary trust levels.
- Set of microservices to feed the Ontology and store instances in a graph-oriented database.
- Microservices that expose information on calculated confidence levels.
- Graph-oriented database with instances of the Ontology for confidence calculations.
- Ontology that defines the entities, relationships, properties, and rules necessary to infer trust levels from the interactions captured in the microservices layer. Extension of the FOAF Ontology.

MODEL VALIDATION

To carry out the validation of the model the ontology was implemented on the Protege software. In the **Figure 5** shows the Ontology implemented on Protege where the relationships defined in the Ontology and inferred by the rules can be seen.

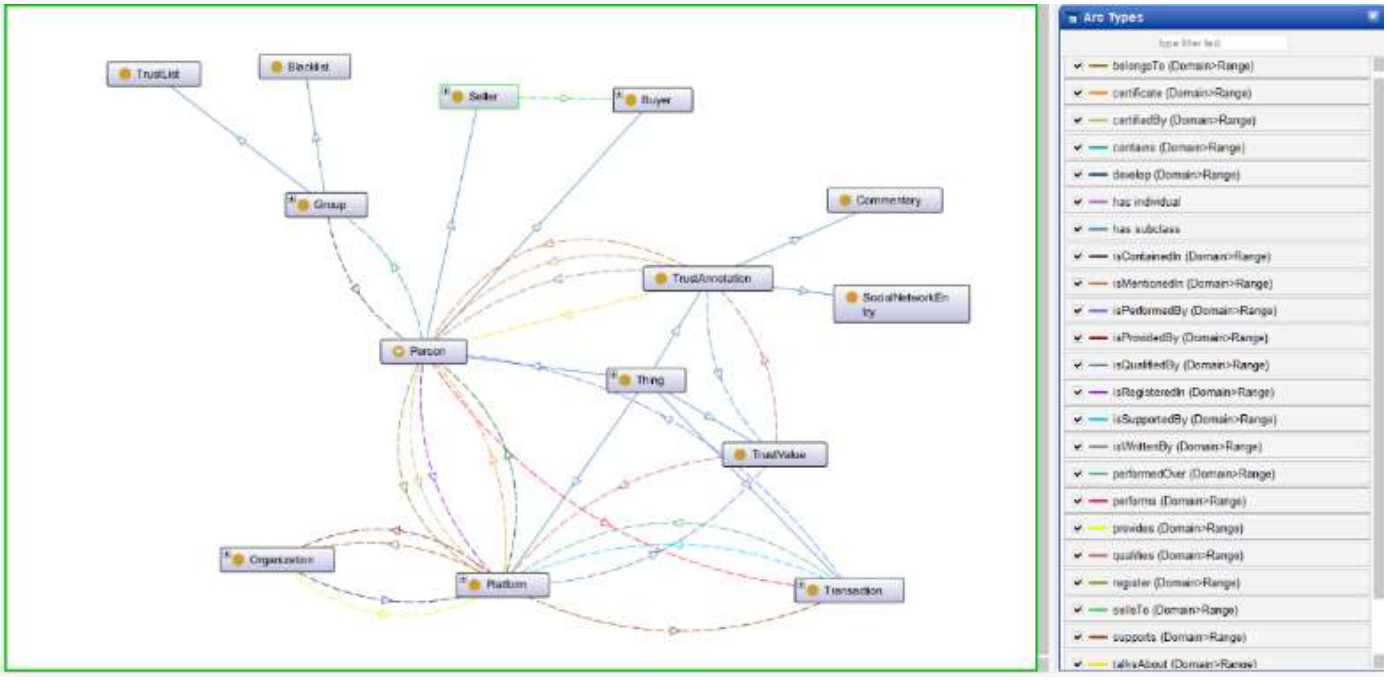

Figure 5. Relations between classes defined in Protege

Four rules were implemented based on the formal Axioms defined according to the methodology to infer the trust evaluation attributes of the entities:

containsMetadata
Expression that validates the presence of trusted metadata about the platform

Platform(?p) ^ name(?p, ?n) ^ webAppUrl(?p, ?url) ^ swrlb:equal(?url, false) ^ swrlb:equal(?n, false) -> containsMetadata(?p, false)

TrustWorthyPlatform
Rate trusted platforms

Platform(?p) ^ isQualifiedBy(?p, ?tv) ^ value(?tv, ?v) ^ swrlb:greaterThan(?v, 0.5) -> trustworthy(?p, true)

inheritedTrust
Rule for inheriting trust from platform to user

Platform(?p) ^ Person(?u) ^ trustworthy(?p, ?tw) ^ swrlb:equal(?tw, true) ^ certificate(?p, ?u)-> trustworthy(?u, true)

inheritedTrust
Rule for inheriting trust from platform to user

Platform(?p) ^ Person(?u) ^ trustworthy(?p, ?tw) ^ swrlb:equal(?tw, true) ^ certificate(?p, ?u)-> trustworthy(?u, true)

As next steps, the implementation of tourism transactional platforms is proposed, that is, on e-Commerce platforms that allow extracting instances of the entities defined within the ontology that supports the model and loading them through the APIs defined within the platform. Once the model has been validated with real data captured from platforms and social networks, the complete architecture can be deployed as a prototype of a trusted platform in tourism sectors on e-commerce based on semantic web.

CONCLUSIONS

Ontology modeling offers a complementary alternative to fourth revolution technologies such as big data, machine learning. This allows a better understanding of the study problem and the approach of logical rules to infer knowledge within modern architectures.

Although the semantic web has not had a technological development like other technologies, there is lot of use cases that it can solve or complement. To promote the use and development of these technologies, it is necessary to develop new cloud products that facilitate access and development of solutions on these technologies. One example of this is the Azure Digital Twins service that use rdf ontologies to model aspects of the real world. It allows to collect data from IOT sensors o and other transactional applications to explain the reality.

As a result of the study, it was possible to propose a model based on the use of ontology trough a trust system for e-commerce platforms with the use of semantic web rules. In the field of tourism is possible to improve the flow of transactional processes and activities that establishment are required within this business model. The four rules defined with the elements of the modeled ontology demonstrate that it is feasible to use logic and reasoning with these tools to infer confidence values. The architecture approach leverages the deployment of these technologies along with modern solution architectures to deliver better user experience, reliability, performance, and usability of semantic applications.

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