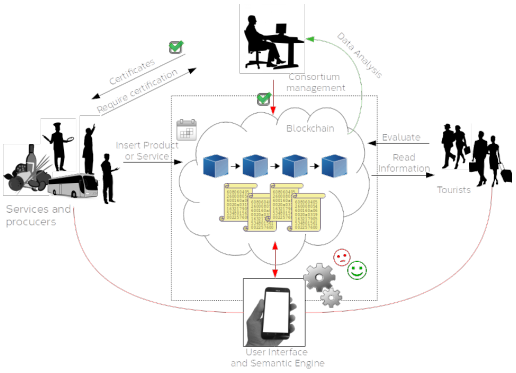
A BLOCKCHAIN APPROACH FOR THE SUSTAINABILITY IN TOURISM MANAGEMENT IN THE SULCIS AREA



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ABSTRACT

The Sardinia island is a well-known tourist destination for holidays, famous for its coasts and its beautiful sea but also for its food. Tourism is one of the most expanding sectors of the regional economy and the use of innovative technology becomes a key element to keep abreast of the times. The complexity of the tourist system is exemplary: it affects several activities and people and influences environmental protection. In this work, we propose a blockchain based platform to guarantee the traceability and the provenance certification of the local agri-food product, to manage and promote the tourism activities in the Sulcis area and to allow tourists to provide their feedback, designing a system that takes into account the sustainability as an objective and a systemic non-functional requirement. Given the complexity of the system and the novelty of the proposed solution, we adopt the Agile methodology, which stresses the attention in customer satisfaction and incorporates sustainability. The adopted approach and the efficiency of the technology due to the security of non-corruptible data, to the use of the cryptography, to the sharing of data between actors in the supply chain, make the proposed system sustainable, competitive and promising for the tourism sector.

KEYWORDS
Blockchain; Sustainability; Provenance Certification; Tourism

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1 INTRODUCTION

Located in the middle of the Mediterranean Sardinia is the second biggest island of Italy. It is one of the most popular tourist destinations for holidays, famous for his 1800 km of coastline and his beautiful beaches and sea. According to Sardegna Turismo[1] , tourists from all around the world claim that five of the most beautiful beaches in Italy are in Sardinia. Sardinia is well known not only for its natural beauty but also for its history, culture and food. A tourist, for instance, can find many excellent local agri-food products of the highest quality, most of them come from craft productions.

Started at the end of 1950, tourism is now one of the most expanding sectors of the regional economy. Its impact can be both positive and negative if it is not adequately planned and developed. Therefore, the use of technology to manage tourism activities becomes a key element for the tourism organization.

We propose a blockchain based system to support tourism services and activities and to promote local agri-food products. Our case study is the Sulcis area, located in the Southwest of Sardinia. Due to the blockchain structure, it is possible to guarantee the security of data and the transparency of information. A record within a blockchain system can not be modified retroactively and information is shared with all the involved stakeholders. In this way, we can guarantee the traceability of products and ensure their provenance. The tourist is the consumer of that products and by using our system he will check the authenticity of the food product, identified by means a QR code. The system through a proper user interface will give back the identity card of the purchased good, that includes some information, from the raw materials used to details about production and distribution phases. Moreover, by using the system, it will be possible to create a network among tourist operators in order to enrich the offer and increase revenues. The tourist can evaluate the purchased product or the enjoyed service through feedback by posting text messages, photos or videos. An external semantic engine connected to the system will analyze all reviews. Tourist operators can improve their services by means of consumers' suggestions.

The tourist system is complex, it involves several activities and people and it influences environmental protection. For those reasons to design our system, we take into account sustainability as an objective and a non-functional requirement. In addition, to develop our system we will adopt the Agile methodology. The methodology puts attention on customer satisfaction and incorporates sustainability.

[1] https://www.sardegnaturismo.it/en/node/252311

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The paper is structured as follows. Section 2 presents related works. In section 3 we describe the approach and the methodology adopted. Section 4 and 5 describe the proposed platform based on blockchain technology and his implementation. Finally, Section 6 contains the conclusions.

2 RELATED WORKSP

Our work is placed in the research macro area regarding the sustainability of the tourism supply chain. This research area is a relatively new discipline. Font et al. (Font, 2008) introduced the analysis of the sustainable supply chain (SSC) applied in the management of tourism. They first analyzed the status of SSC adoption in tourism operators, putting the attention in environmental sustainability, and then individuated the priority area for improvement in SSC management. These areas include accommodation, transport, ground activities, food and local craft producers and supply. The subsequent studies have covered all aspects related to the management of tourism sustainability. In (Szpilko, 2017)
Szpilko analyzed the literature in the tourism supply chain in order to map the research areas. Economic sustainability in the tourism supply chain was the focus of Piboonrungroj and Disney (Piboonrungroj, 2015). They analyzed the origin of economic costs using the method of the transaction costs of each collaboration in the tourism supply chain. Collaborations represent the interaction between the actors of the tourism system, that result very connected and influenced each other. The definition and the design of metrics, software framework and tools for the tourism supply chain has been the subject of growing interest. Jiang and Ke (Jiang, 2019) putted the attention on the importance of the exchange of information between actors of the tourism system, providing a mathematical tool to counteract the bullwhip effect, a point of risk related to the unpredictable volatility of the demand in the top of the supply chain, and to measure performances. Environmental sustainability is the main objective of the framework proposed by Chu and Chung (Chu, 2014) for tourism management. They integrated performance indicators provided by the balanced scorecards and network analysis tools.
In literature, the adoption of the blockchain tourism is under investigation. Calvaresi et al. (Calvaresi, 2019) realized a literature review aiming to identify the point of major interest and to evaluate the point of matching between theoretical results and practical implementation such as *WindingTree* and *Lockchain*. For instance, the goals of startups are to make the travelling cheaper, but also increase improvements of tourism operators. There is a conflict between customer advantages and tourism supplier advantages. In our work, we considered all the actors' objective from a holistic point of view, aiming to the sustainability of the system. Önder and Treiblmaier (Önder, 2018) proposed three research proposition to approach the

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study. The first proposition regards the possibility to collect tourists' reviews and in particular to the possibility to define new trustworthy rating systems. The second proposition regards the impact of the blockchain in the development of new types of customer to customer services given by the adoption of cryptocurrencies. The last proposition regards the distributed and decentralized nature of the blockchain and its possible role in the disintermediation in the tourism industry.

3 OUR APPROACH

Sustainability is a systemic property of processes able to continue in certain conditions for an indefinite time. In other words, this means that the process must be kept active using the available resources. Often, when it comes to sustainability, we focus on economic resources. Process sustainability is actually based on three fundamental pillars, namely Social, Environmental, and Economic Sustainability. Social sustainability is the capability of a system to fit in the society taking into account the involved people, and the socio-cultural context. Environmental sustainability is the capability of a process to continue without consuming natural resources to a greater extent than the natural environment is able to produce in a period of time. Finally, we obtain Economic sustainability if the process uses the economical resources that the process produces itself. The three pillars are interconnected and they contribute to the total sustainability. This means that sustainability involves all the actors in the process. Sustainability is definitively an objective and a non-functional requirement, we have to obtain, regardless of the aim of the system.

In the scenario of the Sulcis tourist system, sustainability is a key element to ensure the continuance of the process by respecting the environment, the social fabric, and economic development. The complexity of the tourist system is exemplary. Take for instance the case of the development of a new tourist destination. It's easy to understand that this will affect several activities, in a waterfall of interactions. For example, will affect the people involved in the management of the passenger service, in the production of local product and souvenirs, in the catering service and in the production of local food, in the overnight accommodation services, in the trekking equipment rental service, etc. Further, given the possibility of new business opportunity, it can lead to the opening of new commercial activity and to the request of loans. In addition, it affects the environmental protection, the protection of the site, and to the empowering of all assistance services.

The management of such a complex process is not easy and is possible thanks to the development of specific software. In this work, we propose a software system to manage a sustainable tourist system. To control the sustainability of the process it is necessary to consider its feedback, or in other words, to know its state. The state of the process is

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composed of the value of a set of specific performance indicators. The design of indicators, the data elaboration, the definition of the actors of the system, and the data acquisition are the elements of the software design. The software system gives to the process the property of visibility, that is the possibility to provide its state to the process manager.

We approach the problem starting from the principles of the sustainable software engineering summarized in the Karlskrona manifesto (Becker, 2015) and in the work of Oyedeji et al. (Oyedeji, 2015) from the Agile methodology which principles are described by Beck et al. (Beck, 2001), and from the innovative blockchain technology.

Our system will be placed in an under development context, both in a technological and administrative perspective. For this reason, we conceived our proposal to be adopted gradually and to be upgradable by adding, removing or modifying features, according to the feedback produced by the tourism system manager and by the other actors. In this way, the system will be able to help the management of the current state of the tourism system in Sulcis and will be ready to face change and novelty of future generation tourism services.

3.1 SUSTAINABLE DESIGN

The software engineering for sustainable design involves the analysis of the process on the base of on a division into five dimensions of sustainability that are individual, social, economic, technical and environmental.

The five dimensions are described by Becker et al. (Becker, 2015) as following.

The individual dimension covers individual freedom and agency (the ability to act in an environment), human dignity, and fulfilment. It includes individuals' ability to thrive, to exercise their rights, and develop freely.

The social dimension covers relationships between individuals and groups. For example, it covers the structures of mutual trust and communication in a social system and the balance between conflicting interests.

The economic dimension covers financial aspects and business value. It includes capital growth and liquidity, investment questions, and financial operations.

The technical dimension covers the ability to maintain and evolve artificial systems (such as software) over time. It refers to maintenance and evolution, resilience, and the ease of system transitions.

The environmental dimension covers the use and stewardship of natural resources. It includes questions ranging from immediate waste production and energy consumption to the balance of local ecosystems and climate change concerns.

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The five dimensions represent the objective of the effects that the software system will produce in the process. In particular, we analyzed the actors of the tourism system in the Sulcis area, according to the division in five dimensions.
In particular, we identified the following representation.
The Individual dimension includes:

- the effects to the tourist, starting from his satisfaction to the creation of the desire to return and the influence to other tourists.
- the effects to the tourism system manager in terms of changes in the quality of his life and in the perspective of a stable workplace.
- the effects to the service provider in terms of personal satisfaction and in terms of their influence on other people for the starting of new tourism services.
- the effects to the producer of local products in terms of satisfaction and quality of life.

All these effects regard actors taken as single individual and concern his possibility to act on the system.
The social dimension includes effects on the social fabric of the Sulcis, and concerns the improvement of social cohesion between different categories, the improvement of communication channels, and the promotion of the development of better social conditions.
The economic dimension includes effects on the revenues of local tourist operators, effects on the local economy and effects on the local financial activities. Economic and social effects are results of the tourism process that can be managed thanks to the feedback provided by our software system. The blockchain technology allows the acquiring of certificated data of productions and sells, and the collection and the sharing of tourist's feedback.
The technical dimension concerns the effects of the proposed software system and its evolution.
As will be described below, we decided to use the agile methodology to allow an incremental design and faster development iterations, continuous communication with the tourism system domain experts, and a change ready software, by exploiting the possibility to customize its smart contracts. The environmental dimension includes effects on the environment of the Sulcis area. Our system can help to manage the use of renewable resources and to organize the tourist's transport in order to reduce the production of pollution and minimize the impact on the environment.

3.2 AGILE METHODOLOGY

Given the complexity of the system and the novelty of the proposed solution, we have chosen to develop the system by adopting the Agile methodology. As described in the Agile principles,

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that methodology puts the attention in the customer satisfaction as the result of the continuous exchange of information between the development team and the customer, that can lead to changing requirements in any stage of the development.

The Agile methodology incorporates sustainability and makes it one of its principles:

- *Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely*[2].

We have chosen the SCRUM methodology, that is one of the Agile methodologies. The development of the tourism management system could face several points of uncertainty. For this reason, we chose is the SCRUM methodology, that allows a development process characterized by being flexible, adaptive and iterative. The SCRUM methodology can emphasize the importance of the communication between the different typologies of users, the product owner and the development team. The chosen blockchain technology is a natural communication channel. All recorded data are shared between actors and always available from the product owner. We identify the role of the Product Owner in the system admin, that is who will manage the tourism system.

In our proposal, we take into account the presence of a set of stakeholders of the tourism process, that, as will be described in the following section, are represented as an actor in the system. In addition, the feedback provided by the tourists, the local producer data, and the tourism services data is collected by the blockchain network and processed by smart contracts and can be used to improve both the tourism services and the system functionalities. The Product Owner, that is the manager of the tourism system, will periodically analyze and process collected data.

The results of the analysis should represent the feedback that the Product owner gives to the developer team. Continuous communication allows giving importance to the users' experience that has a very important role in all the stages of the development process, in order to check the correctness and the efficiency of the system in every development iteration.

3.3 BLOCKCHAIN TECHNOLOGY

The blockchain is well known as the technology that supports Bitcoin cryptocurrency and used for financial transactions. In recent years, due to the success of the Ethereum Blockchain and other platforms that allow implementing smart contracts, blockchain applications have spread to a variety of industries. The blockchain is a distributed and decentralized public ledger, which contains all cryptocurrency transactions. As the name suggests, it is composed of blocks, a

[2] http://agilemanifesto.org/iso/en/principles.html

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growing list of records, chained in chronological order and managed by a peer to peer network. Therefore, a record within the blockchain can not be modified retroactively because of its structure.

To validate a new block, each node of the network has a private copy of the ledger and needs to adhere to a protocol. A blockchain can be considered as a global online database in which information is recorded in a verifiable and persistent way without future manipulation. In addition to transactions, within the blockchain we can record digital data such as documents, or manage information such as identities, food traceability, agreements between parties, etc.. Indeed, by using smart contracts, we can automate processes and make them legally binding. A smart contract is a special typology of account recorded in a block. It can receive and transmit messages from and to other accounts, it contains programming language and it is self execute under some conditions.

By using the blockchain technology, it will be possible to guarantee:

- the security of the information by means the use of cryptography;
- the transparency of information because all actors can access it and audit transactions;
- the trust among parties without the use of an intermediary because the blockchain is decentralized and it is accessed and copied by any node on the network;
- the immutability of information given the structure of the ledger.

4 THE BLOCKCHAIN BASED SYSTEM

We first describe the objective of the system and subsequently the set of actors which interact with the system. Then we define the general architecture and finally, we describe the functionality in terms of *use cases*.

4.1 OBJECTIVE OF THE SYSTEM

We propose a tourism management system to help the sustainable development of tourism in the Sulcis area. To obtain this result we take into account the several aspects of the tourism system, and we identify all the actors involved. In particular, the business logic will be managed by the system with a triple objective:

- create a network among all actors involved in the Sulcis tourism economy. Operators can aggregate their services to promote the local area, encourage tourism and enrich the tourist offer, by offering combined tourist tours, routes with a limited number of participants or last-minute ticket. The customer will receive promotions both through the platform and traditional advertising channels.

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- have feedback from the final consumer. A customer can purchase two different types of product: agri-food product or tourist trail. In both cases, he receives login credentials to the system and he can leave feedback in terms of text message, photo or video. The User Generated Content will be analyzed by an external semantic engine connected to the system with the purpose to improve services and to increase the tourist demand.
- ensure the provenance certification of agri-food local product to guarantee the traceability. All local products registered within the system will be labelled by a QR code. By using a smartphone, the customer will be able to retrieve the product history from raw materials it was originated from, to the production and preservation of the product during the distribution.

4.2 ACTORS OF THE SYSTEM

We identified the following actors in the system.

- System Admin is a figure recognized by all the participants in the supply chain. It is the entity authorized to register the products and to include the various actors within the system. Each actor involved in the process must be authorized and certified to access within the system. In fact, every stakeholder, be it a tourism service provider, a producer or a distributor, must confirm its role by providing all the necessary documentation concerning the work license or any other authorization. Depending on the assigned role, each actor will be enabled to perform a limited set of operations, by recording only certain types of data.
- The tourism service provider is enabled to record data about tourist product such as sightseeing tours, last minute offers or multiple services coupons from different aggregated operators.
- Producer records data about agri-food local product, such as raw materials, processing and production. He can add a new production batch with related information and documents.
- Distributor adds information about the preservation of the product during the distribution phase: i.e. temperature, location. Moreover, he can record data about ownership change.
- Customer adds a review on
- the product purchased, he can also insert photos or videos. In the case of agri-food product, he can verify the integrity by reading all the product history.

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4.3 ARCHITECTURE

The architecture of the system is composed of three main layers, as represented in Fig.1.

- *Consortium Layer* consists of all the stakeholders involved in the tourism activities who sign and share an agreement regarding the tourist products. The purpose of the Consortium is to increase the tourist offer by certifying their product and guaranteeing their reliability.
- *Rest API Layer* provides the integration with the blockchain platform. It allows to signed users of the consortium, to view and interact with blockchain applications, such as execute actions on a smart contract or view contract instances. By using the REST API Layer, a User Interface will access to information recorded within blockchain, to display it to the end user.
- *Blockchain Layer* is the core of the system. It contains all business logic, implemented by using smart contracts. It contains data related to product recorded in a verifiable and permanent way. Users will access information through a properly implemented User Interface.

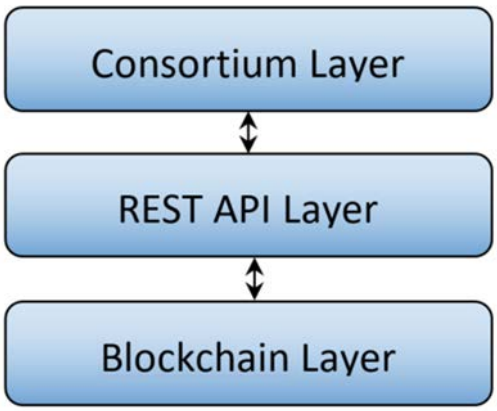

Fig. 1 Architecture of the system

The system manages two different types of data: one deriving from consumers that release feedback. These data are managed by the semantic engine, which analyzes them and returns the result to the BC system. The other one deriving from the other actors of the system.
Whenever a data is recorded in the blockchain, a specific smart contract is called. A smart contract is written in computer code, it allows the automation of processes because it is self-executed under some conditions. More specifically, we will implement a different smart contract for every macro process within the system.

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4.4 SYSTEM FUNCTIONALITIES: A USE CASE EXAMPLE

We present below a possible use case of the system. All the actors involved in the supply chain communicate with the system by using a User Interface. Depending on their role, each actor has different permission and displays different windows. Fig.2 represents the system functionalities and the involved actors.

- A System Admin, as a representative of the Tourism Consortium, entity regulating the tourist service, manages the accessing to the system.
- A stakeholder (or a Producer or a Distributor) requires credential to the Blockchain system providing all documents to certify his role.
- The System Admin issues the credentials to the actor. He records the actor within the system assigning a specific role.
- The Tourism service provider inserts within the system a coupon containing his product service (he adds a description, price, location area, expiration date and other useful information).
- The Tourism service provider inserts within the system a coupon (or last-minute deal) containing different product services from several operators (he adds descriptions, price, location areas, list of operators involved, expiration date and other useful information).
- The Producer inserts within the system a new production batch - related to an agri-food local product - (he adds a description, date, list of raw materials, certifications, expiration date and other useful information).
- The Distributor inserts within the system data related to the production batch: its new ownership and its conservation during the distribution phase (he adds ID production batch, temperature, location and other useful information).
- A consumer obtains information on the purchased product (agri-food product) through a QR code. He can read the product identity card that certifies the traceability and the reliability of the good.
- A consumer can insert within the system feedback on the purchased product. Indeed, he receives credentials to add a review in term of text, image or video.
- An external semantic engine, SE, connected to the system, analyzes the User Generated Content coming from consumers. The SE returns the result of the analysis as a positive or negative review. That information will be recorded within the blockchain system.
- Product reviews will be available to system actors to enhance products and services offered.
- Consumers that granting authorization, will receive the offering and advertising on local product.

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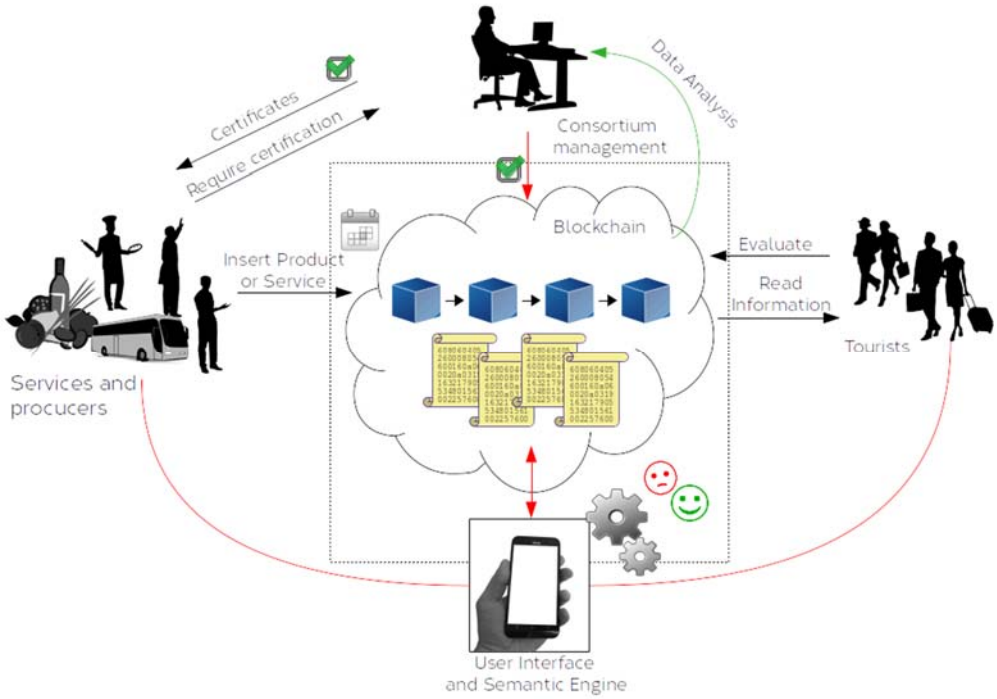

Fig. 2 The System functionality

5 IMPLEMENTATION

In this section, we briefly describe the main software element that composes the back-end of the software system. The first component is the set of smart contracts (SC) that will implement the business logic of the system. The second component is the semantic engine that is connected to the system to acquire and analyze comments and other types of feedbacks coming from the customer.

5.1 SMART CONTRACTS

We identify the following four smart contracts that will manage the business logic of the system.

- *SC-Access*. It is the smart contract responsible for the registration of new actors and for the login. It allows the System Admin to register actors and subsequently it allows actors to login to the system. For the registration process, the SC receives in input the business

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name, the address, the role, the list of recordable products within the system (only for Producer and Tourism service providers). If the registration succeeds, it releases the actor's credentials. In the login phase, the actor sends to the SC its credential. If the credentials are correct, the SC enables access to the platform, with view and permissions dependent on the actor role.

- *SC-Traceability* allows producers and suppliers to record data about agri-food local products. It receives data from producers regarding each specific product, such as raw materials, production techniques, location, the id of the production batch and other useful information. Instead, the contract receives from distributors data about current ownership, storage temperature, location and other useful information.
- *SC-Coupon* is devoted to Tourism service providers. It receives data about tourist attraction such as sightseeing tours, last-minute deal or a multiple service ticket come from different operators.
- *SC-Feedback* manages feedback released by consumers. It records and manages the processed information coming from the semantic engine in terms of positive or negative evaluation.

All smart contracts functionalities will be available to actors by means a proper user interface. Moreover, the interface will communicate with the semantic engine responsible for feedback coming from consumers.

5.1 SEMANTIC ENGINE

The Semantic engine is an external module linked to the blockchain system. It will be designed by using semantic techniques in order to improve the tourist market in the Sulcis area. its main objective is to analyze different types of data (text message, photo, video) coming from several consumers. To define the relationship among concept, the tool will use appropriate ontologies defined in the tourist domain. An ontology includes a representation, a definition of categories, properties, relations between data, entities and concepts that verify one or more domains. In addition, to manage the UGCs the system will use also a folksonomy, namely the operation to categorize the data inserted by users by using keywords or tags, the extraction of terms will be used to enrich an existing ontology (or a classification) or to develop a new one. The only result of the analysis that will be recorded within the blockchain system is expressed in terms of a positive or negative review. The integral result of the analysis will be available to the stakeholders, through the user interface, in order to improve their services or products, enhance their reputation and increase their revenue.

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6 CONCLUSIONS

This paper proposes a blockchain based platform to support the tourism system development by means the promotion of the local agri-food product, the management of services and tourist activities and the collection of tourist opinions. Our system has a triple objective: ensure the provenance certification of agri-food local products to guarantee the traceability, create a network among actors involved in the territory and have a feedback from the consumer in order to enhance products and increase revenues. The system will be used in an under development tourism context like that the Sulcis area, both from a technological and administrative point of view.

The use of the blockchain technology will ensure the transparency and the immutability of the information, will allow trust among parties and guarantee the security of data. Through smart contracts, it will be possible to automate processes and implement new functionalities. The actors will access to information by using a properly implemented User Interface with a customized view, depending on the role. The system will be connected to an external semantic engine whose job is to process feedback and analyze User Generated Content come from consumers. We take into account the sustainability as an objective and a non-functional requirement. Therefore, the use of the system will have benefits for all stakeholders involved, for the territory and for the economy. To ensure the sustainability of the system and according to the Agile methodology, we have conceived our proposal as gradual and updatable by adding, removing or modifying the characteristics, through the analysis of the feedback produced by consumers and the tourism system operator. To sum up, we believe that the proposed system will be able to help the management of the current state of the tourism system in the Sulcis area, and at the same time, it will be ready to face change and novelty of the future generation tourism services.

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