The MiB System: An interactive storytelling experience in the wine industry

Ioannis Chrysakis
FORTH, Institute of Computer Science and Ghent University and KU Leuven
hrysakis@ics.forth.gr
Greece and Belgium

Panagiotis Papadakos
FORTH, Institute of Computer Science
papadako@ics.forth.gr
Greece

Theodore Patkos
FORTH, Institute of Computer Science
patkos@ics.forth.gr
Greece

Giorgos Flouris
FORTH, Institute of Computer Science
fgeo@ics.forth.gr
Greece

Georgios Samaritakis
FORTH, Institute of Computer Science
samarita@ics.forth.gr
Greece

Dimitris Angelakis
FORTH, Institute of Computer Science
agelakis@ics.forth.gr
Greece

Nikoleta Tsampanaki
FORTH, Institute of Computer Science
tsaban@ics.forth.gr
Greece

Nena Basina
FORTH, Institute of Computer Science
basina@ics.forth.gr
Greece

Pavlos Baritakis
FORTH, Institute of Computer Science
pbaritak@ics.forth.gr
Greece

Ariadne Pratikaki
FORTH, Institute of Computer Science
ariadne@ics.forth.gr
Greece

Ilias Loulakakis
Baked Advertising
liakos@baked.gr
Greece

Bart Lyrarakis
Lyrarakis Wines SA
bart@lyrarakis.com
Greece

***Abstract*—The wine industry has evolved over time to tackle the emerging needs of both wine professionals and consumers. Especially during the last decades, there is a growing need for transparency to ensure consumers buy safe, healthy, and environmentally-friendly food products. These details include for example information about the winemaking process, farm practices, or the prevailing weather conditions throughout the year. However, this kind of information does not exist in an integrated information system that could give additional value to both wine producers and consumers. In the frame of the MiB (Message-In-a-Bottle) project we developed an information system (called MiB) that exploits heterogeneous data (e.g., tracebility) from various sources (e.g., sensors, ERP systems) for creating a meaningful story for each wine label. The system is planned to go into the market through the Lyrarakis S.A. winery, one of the industry partners of the project. This paper describes the MiB system which offers a rich ecosystem of services and applications that provide: a) a storytelling-based presentation of wine labels (Main Application); b) wine suggestions based on a food selection, or vice-versa (Le Sommelier Application); c) an interactive authentication and counterfeit report mechanism for wine bottles (Authentication Application); d) an Augmented Reality experience (AR application); and e) a data entry tool (Admin UI Application). These functionalities constitute a robust and powerful tool for wine producers, professionals and consumers.**

***Index Terms*—digital agriculture, wine industry, wine tourism, storytelling, wine recommendations, wine authenticity**

978-1-5386-5541-2/18/$31.00 ©2022 IEEE

I. Introduction

There is a growing trend for consumers to know in detail how the food they consume is produced, for health, quality or attitude reasons [1], [2]. This trend is also true for the wine industry, since wine professionals consumers are interested in more and more specialized information with regards to the wine product itself [3]. This information refers for example to details about the vineyard (e.g., soil texture), the wine matching phase (e.g., use of water), or the wine ingredients (e.g., sugar content). In the wine sector however, this kind of information, even in best case scenarios, is stored internally in database management systems of wine enterprises and, thus, is not available for wine professionals or consumers. Therefore, there is a lack of information systems or other related applications in the industry that aggregate specialized wine information and create value proposition for the wine audience.

A system specialized in wine-related information can help consumers make informed decisions about which wine to buy. Its users should be able to navigate through the available labels and wine characteristics, and finally find the wine that satisfies their needs. This kind of awareness can create a new relationship between the wine producer and the consumer, which will benefit both parties.

Additionally, instead of exposing in a sterile manner the

available information, the concept of creating a story from the available wine data (i.e., storytelling) can maximize the level of engagement and awareness of users to a specific wine brand [4]. Storytelling can communicate the core values of the wine enterprise, by associating them with the product and its area of origin in a fascinating and memorable way that can emerge emotions [5], [6]. Also, it has been applied successfully in the wine industry as a strong marketing and communication technique, especially in the wine tourism domain [4], [6], [7].

In this paper, we present the MiB system developed in the context of the MiB (Message-In-a-Bottle) Project. The aim of the project is to create a web-based wine information system that offers stories for Lyrarakis Winery's labels. The *storytelling* of MiB is based on geological, viticultural, oenological, climatic, cultural and sustainability data, which are fused with multimedia content such as photos and videos, to provide an engaging and holistic overview of each wine label.

In particular, MiB offers the following applications that allow users to: (a) navigate through wine products and their related features by providing a storytelling-based presentation (Main Application), b) register each bottle for validating the authenticity of the product itself and for providing information about counterfeit ones (Authenticity Application), c) interact with a digital label in an augmented reality experience for selected labels (AR Application), and finally, d) manage the data through a user friendly front-end (Admin UI Application).

To the best of our knowledge this is the only information system that exploits real data to create wine stories, offering on top of them sophisticated interactive functionalities like food suggestions and wine authenticity. Although the system has been developed and tested for the labels of the Lyrarakis Wines S.A. wine producing company, it is designed to be generic and can support other wine enterprises as well. MiB aims to let users interact with the product and its characteristics, raise awareness about it and help the consumers take informed buying decisions. This provides wine enterprises a competitive advantage, as it strengthens brand recognition and customer loyalty, essentially increasing sales and profit for the wine producer.

The remainder of the paper is organized as follows: in section II we present related work of storytelling in the wine industry and relevant information systems and applications. Section III analyses the basic characteristics of MiB by presenting its applications accompanied with implementation details. Finally, section IV summarises the MiB contributions and discusses about challenges in the wine industry.

II. Related Work

A. Theory: Storytelling in the wine industry

Creating brand value and establishing a strong relation with consumers are some of the reasons why enterprises engage in storytelling [8], [9]. In the wine industry we can find several case studies assessing storytelling as a means of effective communication and persuasion for the wine consumers and professionals. Storytelling is also widely used in the wine tourism domain, which typically relies on visits to wineries as a touristic attraction. In addition, this visit is frequently enhanced in various ways (e.g., through digital tools [10]) to create a unique experience to visitors and acquaint them with the place that gives each wine its unique characteristics [11]. In [7] the authors show how storytelling can be applied for wine tourism purposes through a case study which took place in Portugal. Specifically, this work focuses on the writing part of the story, and shows how the script of the story can be transformed into a compelling narrative. This is achieved by focusing on important topics related to the wine, such as historical elements and details about the winemaking process.

The importance of including historical elements in the storytelling has also been proved in a study performed in Georgia [4]. In particular, this work shows that when storytelling is based on archetypes and dramaturgies, it can help in establishing a relationship with new wine customer groups and benefit from wine consumers' curiosity and need for knowledge.

The study of [12] reveals that there is a link between the price level of the wine and the appropriate style of the corporate storytelling. Regarding the latter, the authors identified 13 main topics in the respective scripts. These topics include family, history, appellation, grape assemblage, winemaking techniques, financial partners, geography and geology, description of wines, wine ageing, art and culture, organic certification, customers, and technical investments. The authors suggest that storytelling can be adapted accordingly to support different styles of corporate communication to create a sense of luxury and thus contribute to a price increase.

In our suggested storytelling approach, we include most of the aforementioned topics and elements. Specifically, we incorporate historic and folklore data, information about the winemaking techniques, geological elements, and details about the farmers (producers) and their applied techniques of grapevine cultivation. However, our approach does not only apply storytelling in the wine industry in the sense of a theoretical case study related to its effects, but provides a real system (the MiB) that facilitates the creation of the story based on the collected data. In the next subsection, we present relevant applications of storytelling and related information systems that appear in the wine industry.

B. Practice: Storytelling in the wine industry

The adoption of technological tools in the wine sector has been beneficial to the wine industry [13]. These tools provide a practical means to apply storytelling techniques through communication, while offering extra functionalities to their users (i.e., e-commerce sales, recommendations). Therefore, we notice the following categories of tools: *social media, websites, mobile applications, and web-based information systems*; the latter is the case of MiB.

Regarding *social media* recent studies have shown that their usage can be beneficial for attracting more wine consumers and for increasing their loyalty to the wine enterprise [14].

Similarly, winery *websites* that belong either to wine enterprises or other relevant organizations (such as wine associa-

tions) contribute by presenting an attractive wine story for the wine audience [6], [15]. Representative examples of websites exist in Greece (https://winemakersofnorthgreece.gr, https://www.winesofcrete.gr/), in USA (https://www.napavalley.com/), in Australia (https://www.winecountry.com.au/) and in New Zealand (https://www.wine-marlborough.co.nz/), among others.

However, the existing websites usually offer fixed and non-interactive stories. Also, the problem of content management and data curation is open in both websites and social media, as significant resources are needed to create the wine stories and to keep the wine data updated. In MiB, the users enjoy interactive wine stories and a content management facility that tackle these two problems.

With the rise of smart phones, several *mobile applications* have appeared in the wine sector. Excluding those apps that are focusing on online sales, two of the most famous apps (according to downloads in Android Play Store) are the Vivino app[1] and the Living Wine Labels app[2].

The Vivino app provides food recommendations based on wine, whereas the Living Wine Labels offer a storytelling experience by applying augmented reality techniques. Similarly, in MiB, we also offer the recommendation functionality through the Le Sommelier application, and the Augmented reality experience through the MiB AR application. Both applications are embedded in the MiB system, which is web-accessible, platform-agnostic, and thus does not require downloading any specific app.

Finally, new technologies have led to the development of several information systems in the domain of the so-called digital agriculture. These information systems typically manage data ingested by the users or by sensors located at the vineyards [16]. The case of MiB supports both scenarios, aiming to exploit data to create a unique wine story. Examples of information systems that exploit data include a GIS application for viticultural areas [17] and a monitoring system of wine vineyards [18]; however, we are not aware of any information system that exploits data for storytelling in the wine sector, as the MiB does.

III. The MiB System

In this section we present the basic characteristics of the MiB and we analyse its embedded applications. We also give implementation details regarding the MiB model and the applied architecture.

A. Characteristics

The MiB system is coupled with a set of characteristics that make it **easy to use** for both wine enterprises/producers and the wine consumers. These characteristics are the following:

- *Web-based*: it is accessible through any web browser
- *Mobile-friendly*: its interfaces are adapted to mobile devices (e.g., smart phones)
- *Platform agnostic*: the used technologies are not restricted to a specific operating system and do not require any pre-installed software component or library.
- *Multilingual*: it supports multiple languages via its offered model.
- *Easy-access*: the access to MiB is given through the scan of a QR code which is located in the wine labels.

The MiB is comprised of five applications (*Le Sommelier, Authenticity, AR*). Except from the *Admin UI application* which is used for the data entry, all the other applications are embedded in one single interface: *The Main Application*. The Admin UI is accessed only by authorised users of the wine enterprise. The Main Application and its embedded applications are available publicly to all users. A demo of the system is available at *https://mib.devbaked.gr/*. All these applications are analysed in the following subsection.

B. The Applications

1) The Main Application: The Main application[3] offers a storytelling experience upon the available wine labels of Lyrarakis Winery (see for example the "Plyto Psarades Label"[4]).

There are two ways of accessing this application, namely via web browser and via QR code scanning. Different data that are retrieved through the MiB web services are populated in this application and presented accordingly to *two layers of information*. The basic layer contains coarse-grained information: a basic description of the label itself, the producer(s), the vineyard, the winemaking process, the number of acquired awards (if any), food pairing suggestions and cultural elements. This layer is presented to the users through scrolling. The second layer contains more detailed information such as sustainability, meteorological, geological information. This layer is activated by call-to-action buttons which are included in different sections of the interface.

The Main Application includes a mobile friendly menu which appears on the top-right corner and the respective images that appear at the bottom and act as call to actions. Specifically, the QR code-icon activates the authentication process (Authenicity App), the bottle-icon activates the exploring on available labels, and the coutellerie-icon leads the user to the Le Sommelier Application (see Figure1). Note that the AR application has not yet been embedded in the Main Application but this will happen in the next version which is in progress.

The Main Application follows a *component-based design*. Thus, it focuses on presenting the data to the end-user even if a large portion of the information is missing. This helps the application having a consistent design at all times and not losing its identity and its storytelling feeling. In addition, the Main Application's design is *mobile oriented* as the whole process of the scanning and authentication needs a camera and a mobile phone with an available network connection, but it is also responsive and can be browsed from any modern desktop as well as tablets.

[1] https://www.vivino.com/app

[2] https://play.google.com/store/apps/details?id=com.tweglobal.ar19crimes, https://apps.apple.com/us/app/living-wine-labels/id1256839151

[3] DEMO: https://mibproject.lyrarakis.com/demo/

[4] https://mibproject.lyrarakis.com/demo-label/

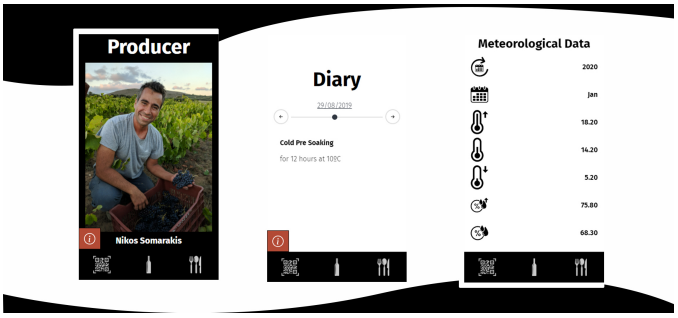

Fig. 1. The MiB Main Application

Fig. 2. The user may browse through diverse food categories to find her dish of preference.

The application is using *session management* to collect data when a user interacts with it. This is critical for the users' experience because by knowing details about users' action the application is able to assist them. For example, in the authentication process, if a user scans a public key but then leaves the application without further interaction (e.g., because something interrupted the process), the MiB Main application provides resuming the process from where it was stopped before, i.e., it does not require the user to re-scan the bottle.

The MiB Main Application is built using the Laravel Framework[5], which is a web application framework written in PHP providing powerful, ready-to-use features such as dependency injection, expressive syntax, and optimized and scalable code. Except from the MiB database the MiB Main application also employs a local database (MySQL) that captures various application data essential to the application's core logic, such as settings, menus, global string translations and asset file locations.

2) Le Sommelier Application: Le Sommelier application is a recommendation system that helps users of the MiB system *pair wine with food* in a way that aims to enhance both the experience of the user and the information she receives. In comparison to the plethora of similar systems that attempt to facilitate the process of wine pairing for the non-expert, our system incorporates a number of unique features.

[5]https://laravel.com/

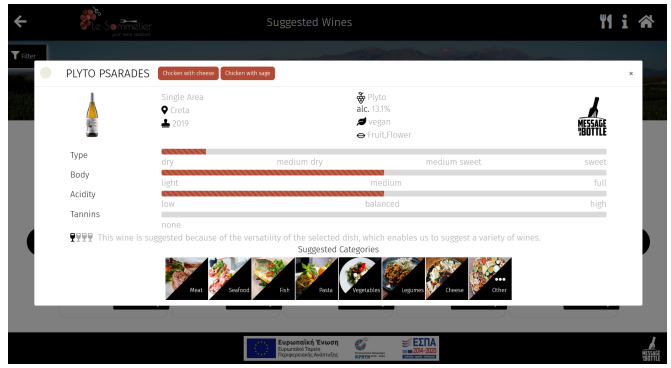

Fig. 3. Le Sommelier recommends wine labels that match the users' selected dish(es), presenting information about the specific label, along with a textual justification for the recommendation.

For start, Le Sommelier enables wines suggestions that nicely pair to multiple, potentially diverse in flavor and characteristics, dishes. This is a common situation met when preparing meal for a group of people who freely choose their food of preference from a menu of diverse choices (see Figure 2). In such a case, while one wine label may be optimal for one dish and another for the other dish, none of them may be considered best match for both dishes; instead, a third wine label that nicely pairs with both choices could be the match that will best enhance the flavor of all the dishes chosen. This is a combinatorial problem that, considering the significant level of subjectivity involved when choosing wines, calls for solutions that are both explanatory to the user and easily adaptable to new preferences and needs.

We, therefore, decided to model the domain experts' knowledge in food and wine pairing as *logical rules*, rather than hard-coding pairings as done by the majority of existing systems. We did not rely exclusively on historical data of past user choices either; such an approach would considerably reduce the creativity that a human sommelier uses when making suggestions. Le Sommelier models domain and empirical knowledge in the form of strict and weak prioritized rules, and performs logical reasoning using declarative languages. Specifically, all rules are modeled in the language of Answer Set Programming [19], while reasoning is executed with the state-of-the-art Clingo tool[6], designed to solve difficult search problems. This modeling, among others, offers flexibility in modifying the set of rules that are applicable according to needs, while enhancing the explainability of the matching process.

Indeed, another distinctive feature of Le Sommelier is the possibility to accompany each suggestion with a *textual explanation* that aims to justify why a given pairing is considered suitable. The explanation may highlight aspects, such as the cooking or flavors of a dish in combination with the tannins, body or acidity of the wine (see Figure 3). In addition to the explanation, the application provides a rating of each suggestion, enabling the user to explore different choices

[6]https://potassco.org/clingo/

before finding the one that best matches her preferences. Moreover, the ability to *filter suggestions* with criteria such as wine type is also provided.

To complete the interaction experience of the end user, Le Sommelier incorporates a number of other features, such as pages with *recipes* for selected dishes. Specifically, in addition to popular dishes from various cuisines, the system suggests local dishes with peculiar characteristics whose preparation involves interesting insights in local traditions. For these dishes, the application provides recipe information, such as the ingredients, cooking process and execution time. This feature nicely couples with the purpose of the MiB system to engage the user in a storytelling experience; after all, the connection of food and wine is deeply embedded in the Cretan culture through the ages.

Finally, the system also supports the *inverse workflow*, i.e., for the user to choose a wine label, for which Le Sommelier will suggest matching food categories and dishes. Such information is already available at the label of each bottle, but considering the variety of dishes, the recipes, and the filtering mechanism that the system offers, such a direction is also proven important.

3) The Authenticity Application: A crucial aspect of food safety, quality assurance, and of avoiding fraud and adulteration is the authenticity of food products, especially for products like wine and olive oil[7]. Most existing approaches are based on various authenticity tamper-evident security stickers and labels that use holograms. However, such labels are generally costly, require expensive equipment, and do not provide any kind of information to the producer about the possible counterfeit products[8]. In the MiB we took a different *crowdsourcing approach*, that is based on pairs of public and private keys represented as QR codes.

Consumers register authentic bottles by inserting the public and private keys in the system. If the pair is valid then the bottle is considered an authentic one, else the users are asked to add more information about the location / sale place of the bottle, since this bottle is treated as a counterfeit one. Since the whole process is based on plain QRs, the approach does not require specialized hardware but plain commodity QR printers. Our approach guarantees that even if someone duplicates the public and private keys of a authentic bottle to create a batch of counterfeit bottles, only one such bottle can be registered as authentic, while the rest will be reported as already registered bottles. Therefore potential consumers will be notified that they are buying counterfeit wines, even when the bottle lies on the shelve of a wine retailer.

In more details, we use an opaque sticker on the bottle that has two QR codes, one visible and one hidden in the back side of the sticker (a special kind of one-time stickers to avoid tampering). Both QRs are UUIDv4 that are generated using random numbers. A UUID is a universally unique identifier across time and space that is represented by a 32 character sequence of letters and numbers separated by dashes. A sample of $3.26 * 10^{16}$ UUIDs has a 99.99% chance of not having any duplicates, which is adequate for our use case.

The pairing of the QRs is done during the bottling process of a batch in the winery. To make the process even easier, error-free and without requiring any kind of QR readers in the bottling line, we pair a list of n public unique system-generated QRs, where n is at least as large as the size of the bottles in the batch, with a pool of private unique system-generated QRs of size n. A consumer can scan the public QR in the MiB to check whether the public UUID is a valid UUID and whether another bottle with this UUID has already been registered. If the latter holds, then (with a very high probability) this specific bottle is not an authentic one. If this UUID is not registered, then the user can try to register it by removing the sticker and scanning the private UUID. Notice that this presupposes the consumers to be informed about the existence of such a sticker for authenticating a bottle (e.g., through the winery's web page).

If the private key is in the pool of the private UUIDs for this specific batch, then the private UUID is removed from the pool and the bottle is registered. If this process fails repeatedly, it means that this is a non-authentic bottle and we let the consumer add more information about the status of this bottle (e.g., purchase location information, general comments). In this way, the producer can get more information about places that non-genuine bottles are offered. If the Do-Not-Track header is not enabled in the client, we also keep an one way cryptographic SHA2-256 hash of the client's IP and its browser signature during the registration process. This hash is used for notifying consumers that they have already registered a bottle and to avoid the insertion of non-valid information. Notice that the client information is stored encrypted and cannot be decrypted for privacy-preserving reasons.

This interactive process creates a relation of trust between the consumers and the producers, and can be incentivized by offering rewards or a gamification approach to customers that register their bottles.

4) The AR Application: The Augmented Reality (AR) application aims at letting consumers interact with the digital label of a corresponding wine label, in an engaging way using WebXR[9]. WebXR is currently offered on top of google's AR services[10] for latest mobile devices and is supported by enabling the WebXR incubation flag available in latest chrome browsers[11]. The application overlays a digital interactive label on top of the real-world one, which has to be tracked accurately in real-time and in various light conditions.

Label tracking is a difficult task that imposes specific characteristics to the images that can be successfully tracked. Specifically, it presupposes highly-contrasted images, with many corners and distinctive features, while the available image tracking algorithms use grayscale images only, ignoring any available color information.

[7]https://joint-research-centre.ec.europa.eu/scientific-activities/food-authenticity-and-quality_en

[8]https://pitchengine.com/pitches/3c7896dc-377a-40c2-bf9b-5ff787b21dff

[9]https://www.w3.org/TR/webxr/

[10]AR services 1.29.213210223

[11]Chrome 98.0.4758.101

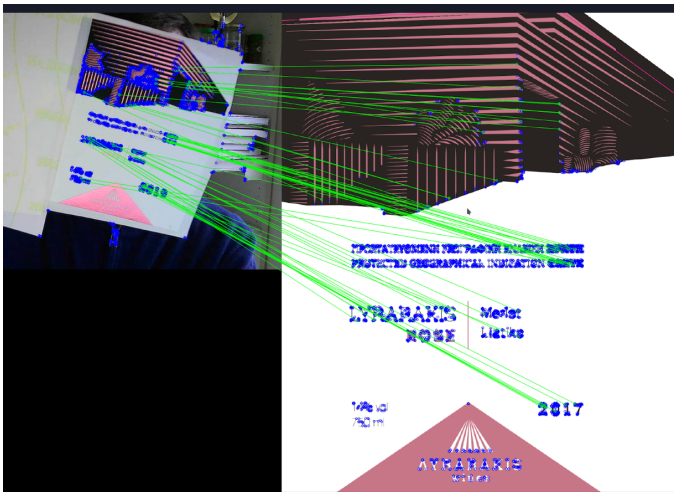

Fig. 4. With blue dots are depicted the recognized features of the labels and with green lines the corresponding mappings between the learned label features (right) and the recognized features of a real-world label (left). Notice that most of the features of the camera image are not mapped.

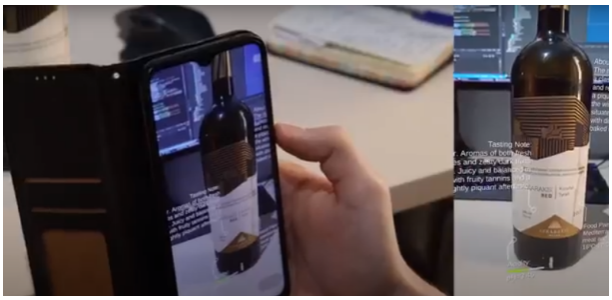

Fig. 5. Indicative screenshot of the under development AR application (WebXR).

The current labels of the Lyrarakis Winery, do not satisfy most of the above criteria, since they use quite similar patterns, while colors, even reflective ones like silver and gold, are used for distinguishing between the various labels. The evaluation of the labels over the various image tracking algorithms in the OpenCV library[12] (e.g., ORB algorithm), showed that most of the labels have a low image entropy value of (~ 1)[13]. As an example, Figure 4 shows the identified label features and their incomplete mappings to the recognized label features of a real-life label through the mobile camera. Apart from the WebXR AR application we also developed a native Android application using the Unity[14] library that provides proprietary image tracking algorithms, but we found no real improvement in the image tracking quality.

Since the redesign of the labels was not acceptable, we focused only on a subset of the available winery labels for which we managed to get acceptable performance. This subset includes most of the Protected Geographical Indication

[12]https://opencv.org/

[13]Image entropy value measures the level of complexity of an image and takes values from 0-5 in our case

[14]https://unity.com/

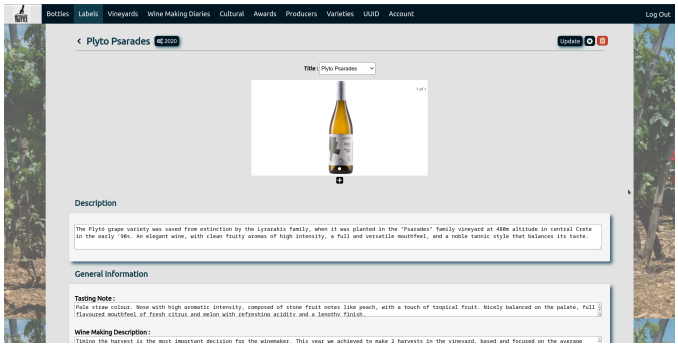

Fig. 6. Admin UI: Editing a wine label.

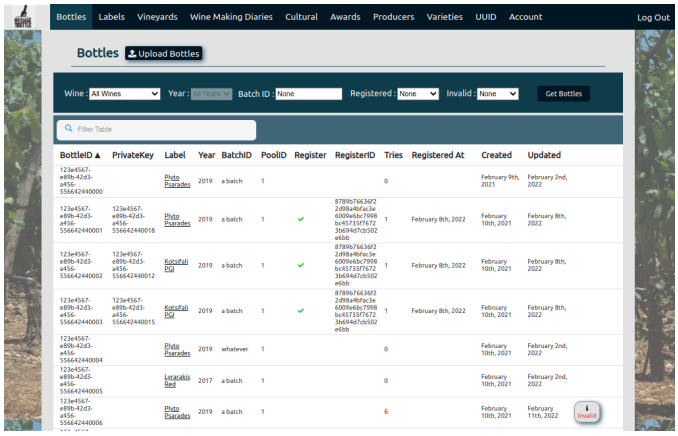

Fig. 7. Admin UI: Exploration functionality of original and counterfeit bottles.

(PGI) labels that depict the field that produces the grapes. We only use the part of the label that depicts the field for tracking and ignored the rest. For each recognized label, the application depicts a swipe-able pane, where information about this specific label is given (e.g., label characteristics, producer, awards, wine making diaries, producers, etc.).

Figure 5 shows an indicative screenshot from the AR application, which is still in development. The AR application is developed using the javascript library babylon.js[15],[16].

5) The Admin UI Application: The Admin UI[17] offers a content management facility for authorized MiB users (administrators). Through this application, producers/wine enterprises can manage the MiB data and adapt the wine story for each label accordingly. In addition, the application offers an exploratory service for monitoring the bottles that are available in the market along with any non-genuine bottles and their associated information added by worldwide customers. Figure 7 depicts the bottles exploration functionality.

Admin UI was implemented in React[18] and uses the available MiB services with a corresponding JWT token for authorization purposes. The Admin UI enables to retrieve,

[15]https://www.babylonjs.com/

[16]We are using the alpha snapshots of the 5.0 version that supports WebXR.

[17]DEMO:https://mibproject.lyrarakis.com/demo-admin/

[18]https://reactjs.org/

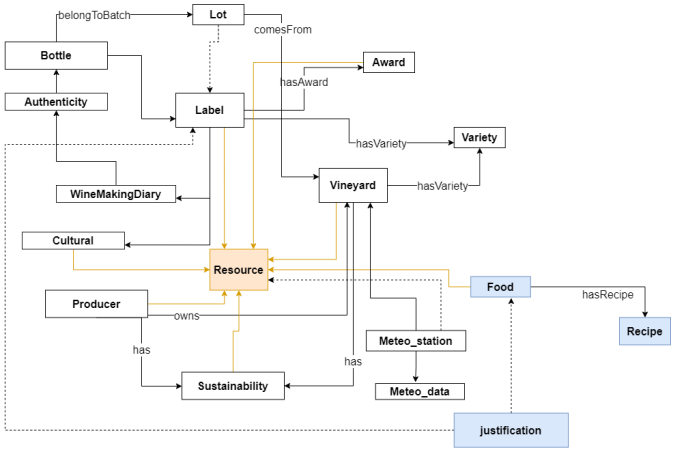

Fig. 8. The MiB Model.

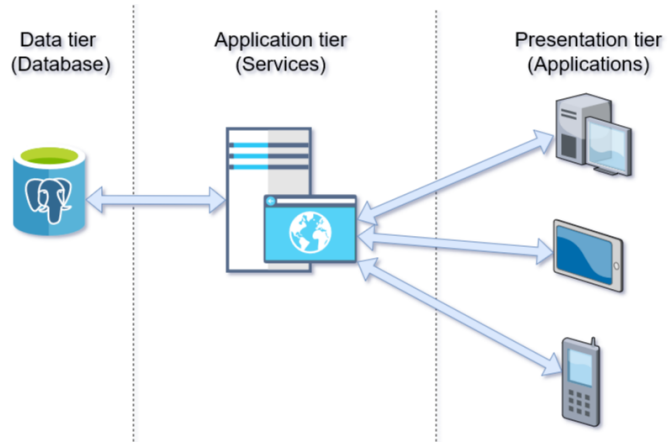

Fig. 9. The Typical 3-tier architecture applied in MiB.

add, update, and delete the bottles, authentication, labels, wine making diaries, cultural, award, producer, varieties, weather and sustainability data (e.g., Figure 6)

C. Implementation

The **MiB model** (Figure 8) embraces all important entities that typically appear in a wine story [4], [6], [12]. Thus, it captures information related to:

1) details of the wine label, such as year, flavor, alcohol and acidity (*Label entity*)
2) variety details such as the color and the name (*Variety entity*)
3) historic and folklore elements (*Cultural entity*)
4) sustainability information such as water management, farming soil health, manufacture waste (*Sustainability entity*)
5) meteorological information as captured by the installed vineyard weather stations (*Meteo entity*)
6) vineyard information such as the altitude, location, other viticulture details such as irrigation, ripening (*Vineyard entity*), the producers (*Producer entity*)
7) wine making details including a wine making diary (*Wine Making Diary*)
8) food elements including recipes and justifications captured in the respective entities *Food, Recipe, Justification*
9) awards details for specific years of labels (*Award entity*)
10) authenticity information that denotes if a specific bottle has been already registered (*Bottle entity*)

To support content in different languages we followed the approach of creating entity layers for translated fields and non-translated fields. This option is a proven approach of incorporating multiple languages across entities[19]. With this solution, entity tables which contain one or more translated fields are split into two layers: one for translated fields, and another for non-translated fields. Consequently, there is no need to join translation tables if only non-translated fields are concerned,

[19]https://vertabelo.com/blog/data-modeling-for-multiple-languages-how-to-design-a-localization-ready-system/

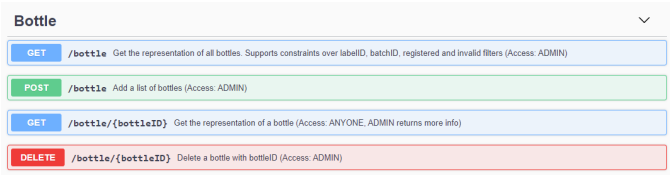

Fig. 10. Bottle Resource HTTP methods.

which allows non-translated fields to exhibit better data access performance. In order to make this approach transparent to the MiB applications, we created specific views for each entity, one for each necessary language. Database transactions (insert, delete, update) are performed using the views and not the actual database tables. This is accomplished through a created set of stored procedures and database triggers.

Regarding the **architecture** of the MiB system, we followed a typical 3-tier architecture (See Figure 9). Therefore, different applications reside in the *Presentation tier* and they communicate with the *Data tier*, that contains the database, through the *Application tier*. The database implements the MiB model using PostgreSQL[20].

A Web services component corresponds to our *Application tier*. Since the MiB is web-based, the most straightforward way to implement the application tier is by using web services. We opted for RESTful Web Services since they promise reliable, fast and scalable services [20].

In particular, we defined different resources for the entities of our model to offer the respective REST services. Each REST resource defines its functionality by means of HTTP methods. As an example, consider Figure 10 which contains the methods of the Bottle entity. Any client (having the right permissions) may make use of these methods to get a list of all bottles (first GET method), add a bottle (POST method), get a specific bottle (second GET method), or delete a specific bottle (DELETE method).

The MiB web services component were implemented with

[20]https://www.postgresql.org

the Javalin framework[21], which runs on top of Jetty[22], one of the most used and stable web-servers on the JVM. Javalin also supports OpenAPI[23], thus allowing easy documentation generation and client code generation. All these factors combined guarantee that this component is lightweight, flexible and easy to be consumed by any other client application. The offered REST API of MiB is available online[24].

The *Presentation tier* ensures that all embedded applications will have the same look and feel in order to not distract the users from the storytelling experience. It also guarantees that all the aforementioned characteristics (subsection III-A) are applied in all applications. Implementation details for the presentation tier are given separately for each application (subsection III-B).

IV. Conclusion and Discussion

In this paper we presented the outcome of the MiB project (MiB system) which offers an innovative digital solution in the wine sector by providing an interactive storytelling experience. The system has been tailor-made for the Lyrarakis Winery, but can be easily adapted for the needs of other wineries.

MiB offers multiple benefits for the wine audience and, thus, for the Lyrarakis Winery as well. First of all, it offers transparency and tracebility to users by exploiting aggregated data. The aggregated data become parts of a unique wine story per wine label to provide engagement and loyalty to users. The MiB users will not only get informed about the wine product, but they will also have the ability to interact through MiB applications to receive wine suggestions and augmented reality experiences. Moreover, by offering authentication, MiB contributes to food safety since it guarantees the origin of the wine. Authenticity in turn, gives a competitive advantage to wineries [21].

Particularly for Lyrarakis Winery, on top of all the aforementioned benefits, the MiB system has achieved organising, structuring a complex set of data that helps describe many of the dimensions of wine. This approach, and the need to keep data up-to-date (as it will be publicly available) will be an extra driver of thorough reporting and record-keeping, which is a very important practice to improve product quality.

Also extensibility and scalability have been proven to be an advantage of the MiB system, as during the MiB project's second year, the legal obligation arose for wineries in the EU to support access of consumers to nutritional information of each wine[25]. The EU allowed wineries to redirect consumers to a website through a QR code, which is what MIB system also uses as an entry point to its Main application. The architecture and the implementation of MiB allows an easy integration of the above requirements.

[21] https://javalin.io/

[22] https://www.eclipse.org/jetty/

[23] https://www.openapis.org/

[24] https://dev.isl.ics.forth.gr/mib/

[25] https://ec.europa.eu/food/safety/labelling-and-nutrition/food-information-consumers-legislation/alcohol-labelling_en

Finally, we argue that the MiB system will help Lyrararakis winery to stand out from the competition, by offering an easy to use digital product which is meaningful to all involved parties in the wine industry.

Acknowledgements

This work has been funded by the European Regional Development Fund, Business Program Crete 2014-2020 in the frame of MiB Project (KPHP1-0028556).

References

[1] L. Nagyová, A. Andocsová, A. Géci, P. Zajác, J. Palkovič, I. Košičiarová, and J. Golian, "Consumers'awareness of food safety." *Potravinarstvo*, vol. 13, no. 1, 2019.

[2] K. G. Grunert, "Food quality and safety: consumer perception and demand," *European review of agricultural economics*, vol. 32, no. 3, pp. 369–391, 2005.

[3] M. D'amico, G. Di Vita, and L. Monaco, "Exploring environmental consciousness and consumer preferences for organic wines without sulfites," *Journal of Cleaner Production*, vol. 120, pp. 64–71, 2016.

[4] P. Rytkönen, L. Vigerland, and E. Borg, "Tales of georgian wine: storytelling in the georgian wine industry," *Journal of Wine Research*, vol. 32, no. 2, pp. 117–133, 2021.

[5] M. Sigala and R. Robinson, *Wine tourism destination management and marketing*. Springer, 2019.

[6] C. Bonarou, P. Tsartas, and E. Sarantakou, "E-storytelling and wine tourism branding: Insights from the "wine roads of northern greece"," *Wine Tourism Destination Management and Marketing*, p. 77, 2019.

[7] V. Woldarsky, "Tapping into the emotions of the wine consumer through storytelling: A case study," in *BIO Web of Conferences*, vol. 15. EDP Sciences, 2019, p. 03012.

[8] A. G. Woodside, S. Sood, and K. E. Miller, "When consumers and brands talk: Storytelling theory and research in psychology and marketing," *Psychology & Marketing*, vol. 25, no. 2, pp. 97–145, 2008.

[9] S. Herskovitz and M. Crystal, "The essential brand persona: storytelling and branding," *Journal of business strategy*, 2010.

[10] A. Dorofeeva, A. Kazak, and L. Nyurenberger, "Wine tourism and the introduction of new technologies in winemaking and viticulture," in *IOP Conference Series: Earth and Environmental Science*, vol. 315, no. 7. IOP Publishing, 2019, p. 072040.

[11] D. Getz and G. Brown, "Critical success factors for wine tourism regions: a demand analysis," *Tourism management*, vol. 27, no. 1, pp. 146–158, 2006.

[12] P. Mora and F. Livat, "Does storytelling add value to fine bordeaux wines?" *Wine Economics and Policy*, vol. 2, no. 1, pp. 3–10, 2013.

[13] N. Barber, D. C. Taylor, and C. S. Deale, "Wine tourism, environmental concerns, and purchase intention," *Journal of Travel & Tourism Marketing*, vol. 27, no. 2, pp. 146–165, 2010.

[14] G. Szolnoki, D. Taits, M. Nagel, and A. Fortunato, "Using social media in the wine business: an exploratory study from germany," *International Journal of Wine Business Research*, 2014.

[15] A. Duarte Alonso, A. Bressan, M. O'Shea, and V. Krajsic, "Website and social media usage: Implications for the further development of wine tourism, hospitality, and the wine sector," *Tourism Planning & Development*, vol. 10, no. 3, pp. 229–248, 2013.

[16] B. Charnomordic and B. Tisseyre, "Meeting digital challenges in the sector," 2016.

[17] E. A. Takow, E. W. Hellman, A. G. Birt, M. D. Tchakerian, and R. N. Coulson, "A web-based geographic information system application for description of american viticultural areas in texas," *HortTechnology*, vol. 23, no. 2, pp. 165–172, 2013.

[18] K. Smiljkovikj and L. Gavrilovska, "Smartwine: Intelligent end-to-end cloud-based monitoring system," *Wireless Personal Communications*, vol. 78, no. 3, pp. 1777–1788, 2014.

[19] V. Lifschitz, *Answer set programming*. Springer Berlin, 2019.

[20] L. Richardson and S. Ruby, *RESTful web services*. " O'Reilly Media, Inc.", 2008.

[21] W. Frost, J. Frost, P. Strickland, and J. S. Maguire, "Seeking a competitive advantage in wine tourism: Heritage and storytelling at the cellar-door," *International Journal of Hospitality Management*, vol. 87, p. 102460, 2020.