Research Article / Araştırma Makalesi

QUERYING CADASTRAL PARCEL DATA DEFINED BY INSPIRE URI MODEL BY USING QR CODE: TURKISH CASE STUDY

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ABSTRACT

Together with the development of modern technology, a new communication media for accessing to the quality information has emerged. In order to access quality information faster and more practically, Web technology has been developed by Tim Berners-Lee. With this technology, Web users are able to access to the information in Web environment by entering web site URI (or URL) addresses, searching and following the related links. URIs with not only Web documents also possible to define the real world concepts. URI technology has been started with the identification of spatial objects from this property and has been investigated in this study can be accessed via the web positional information of the object. For this purpose, the spatial objects (plots) for INSPIRE URI specific to each model are defined by reference to a spatial objects and to access web resources that is associated with this definition URI QR (Quick Response) code technology is used. To flesh out the application on the basis of the plot interrogation practices have been implemented by the General Directorate of Land Registry and Cadastre in Turkey an alternative to QR coded interrogation practices designed plots and compared with the current interrogation practices of the parcel. According to preliminary results of the comparison QR code to enter information for users with questioning parcels making improper interrogation practices in preventing the pos sibility of questioning is reduced to zero and conducted more practical and faster than the current interrogation practices parcel.

Keywords: INSPIRE URI model, QR code, TKGM, querying parcel.

INSPIRE URI MODELİ İLE TANIMLANMIŞ KADASTRAL PARSEL BİLGİLERİNİN QR KOD İLE SORGULANMASI: TÜRKİYE VAKA ÇALIŞMASI

ÖZ

Modern teknolojilerin gelişmesiyle birlikte nitelikli bilgiye erişim için yeni iletişim ortamları ortaya çıkmıştır. Nitelikli bilgiye daha pratik ve hızlı erişebilmek için Tim Berners-Lee tarafından www teknolojisi geliştirilmiştir. Bu teknoloji ile birlikte Web kullanıcıları web ortamındaki bilgilere URI (veya URL) adreslerini belirterek, tarama yaparak ve ilgili bağlaçları izleyerek kolayca erişmektedir. URI'ler ile yalnızca Web dökümanları değil aynı zamanda gerçek dünya kavramları da tanımlanması mümkündür. URI'nin bu özelliğinden yola çıkarak bu çalışmada konumsal nesnelerin URI ile tanımlanması ve bu konumsal nesnelere ait bilgilere web üzerinden erişilebilmesi araştırılmıştır. Bu amaçla konumsal nesneler için INSPIRE URI modeli referans alınarak her bir konumsal nesneye özgü URI tanımlanmış ve bu tanımlı URI'nin ilişkili olduğu web kaynağına erişmek içinde QR (Quick Response) kod teknolojisi kullanılmıştır. Uygulamanın somutlaştırılması için Türkiye'de Tapu Kadastro Genel Müdürlüğü tarafından uygulamaya konulan parsel sorgulama uygulaması baz alınarak alternatif bir QR kodlu parsel sorgulama uygulaması tasarlanmış ve mevcut parsel sorgulama uygulaması ile karşılaştırılmıştır. Karşılaştırılma sonucuna göre QR kodlu parsel sorgulama uygulaması ile kullanıcıların sorgulama için parsele ait il, ilçe, mahalle/köy, pafta ve ada numarası gibi ön bilgilerin girilmesi engellenerek hatalı sorgulama yapmasına ihtimali sıfıra indirgenmiş ve mevcut parsel uygulamasına (6 adım ve yaklaşık 30 saniye) kıyasla daha pratik (2 adımda) ve hızlı (yaklaşık 5 saniye) sorgulama gerçekleştirilmiştir.

Anahtar Sözcükler: INSPIRE URI modeli, QR kod, TKGM, parsel sorgulama.

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1. INTRODUCTION

With the development in web technology, it is now possible to access any source of information via internet independent of time and space. Ensuring the communication between the user and the server thanks to HTML (HyperText Markup Language), URI (Uniform Resource Identifier) and HTTP (Hypertext Transfer Protocol) structures consisting the basis of web technology; it is possible to access the related web content [1]. HTML is a system consisting of code parts called tag, and that specifies how the documents will be linked to each other and how the texts and pictures in the document will be located. URI is an address used to access a specific source on the web (internet site, document, picture etc.) and that is defined according to a particular format [2, 3, 4]. HTTP is a system regulating the rules and methods on how to transmit information on the internet between the server and clients [5]. In order to access information resource, an address identification system characterized as Uniform Resource Locator – URL was designed by Tim Berners-Lee. URL format is in the format of UNIX directory structure and it is possible to access a requested document via defined protocols on World Wide Web thanks to this address string [6]. URL is a locater indicating the location of a source on the Web and it is a sub-set of URI [7]. Two sources different from each other can be accessed from URI (Figure 1). These sources are called as RDF document and HTML document for software and people respectively. Both of the documents have an URI each, accessible through the web. URI for HTML document was designed so that the source could be perceived and understood visually by the users. HTML document URI structure was used in application as this study is related to the information to be seen on the screen by the users following inquiry.
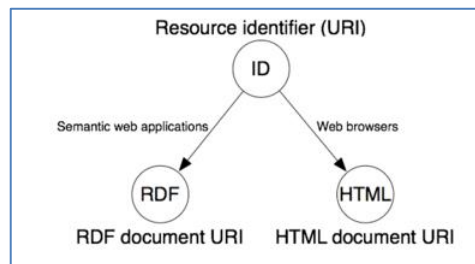
Figure 1. URI subcomponents [8].

Making use of this technology on the web, Infrastructure for Spatial Information in the European Community-INSPIRE suggested to define spatial objects in generic conceptual model with URIs and developed several modelling rules [9]. It is aimed to specify, monitor spatial objects, allow for reuse of such and make connections with other data sets with URI, designed according to the model [10]. In this study, an original URI identification regarding each parcel defined in parcel registration system in Turkey was envisaged taking INSPIRE URI model as an example and it was thought that information that belongs to the parcel could be accessed from this URI, independent of time and location by the users. QR code application was utilized in order to prevent users to input preliminary information (e.g., province, town, district/village names and section and block number) and access query result page directly. In order that this thought could be used implemented in practice, parcel inquiry application of TKGM was handled and it was suggested to create a QR, one for each, with URI content regarding each parcel using the infrastructure of this application. It was planned to imprint the created QR code with URI content legibly on the land certificate. It will be ensured that users can perform quick and easy inquiry without a requirement to enter any preliminary information by the user thereby encoding the QR code with the URI content on the land certificate by means of a QR code reader

application by the user. Thus users will be enabled to perform a more reliable, easier and quicker inquiry. This application was designed as an alternative inquiry system in addition to the current parcel inquiry system. Thanks to URI addresses defined for each parcel, it will be ensured to follow information regarding the parcel (e.g., information on province, town, district/village, block, plot, layout number, type and area of the parcel) and it will be possible associate them with other data sets.

INSPIRE URI model is analysed in the second part of the study; parcel inquiry application of General Directorate of Land Registry and Cadastre (TKGM) is described in the third part; QR code technology is mentioned in general in the fourth part; it is told in the fifth part how to establish a relation between QR code and URI system; inquiry application through QR code with URI content is stated in the sixth part; current inquiry application of TKGM is compared with parcel inquiry application through QR with URI content in the seventh part and overall status of the application is evaluated in the result part.

1.1. INSPIRE Cadastral Parcel Identification: URI model

In INSPIRE conceptual data model, structures such as spatial objects and code lists are recommended to be identified through URIs and; URI modelling rules are specified. The use of URIs as spatial object identifier in INSPIRE allows for identification, supervision and reuse of spatial objects and it enables to establish connections with other data sets [11]. Separate modelling requirements are specified under INSPIRE for spatial objects and spatial things. INSPIRE recommends following http://{subdomain}.{domain}/{type}/{metadata}/{authority}/{localid}/{version} URI model for spatial objects and describes the components of this model on the sample of following URI address http://location.data.gov.uk/so/ef/SamplingPoint/bwsp.eaew/36800 defined by Europe Environment Agency (Table 1).

A cadastral parcel sample identified with INSPIRE URI model is presented in Figure 2.

Figure 2. Spatial object URI identified with INSPIRE URI model [11].

A cadastral parcel in real life (spatial thing) is represented through http://kataster.exmaple.de/id/parcel/07/123/28/255-1 URI; and the URI referring to the model of the parcel (spatial object) is represented through http://location.example.de/so/AAA/DERPAL00ah5ztj3js2. GML document providing

information about the parcel is defined through http://xyx.de/doc/parcels?...&ID=DERPAL00ah5ztj3js2 address.

Table 1. URI structure defined according to the spatial objects [9].

A spatial object URI	http://location.data.gov.uk/so/ef/SamplingPoint/bwsp.eaew/36800 This is the location where bathing water is sampled on a regular basis
{subdomain}, {domain}	http://location.data.gov.uk UK established a domain —data.gov.uk‖ for all public sector data and the UK Location Programme who coordinate INSPIRE in the UK established a —subdomain‖ of location. [Others are environment, health, education, transport etc.]
{type} of resource	/so This denotes that the resource is a spatial object
INSPIRE {metadata}	/ef/SamplingPoint This is not essential but countries like the UK have included the INSPIRE theme and spatial object type in the URI. Potentially this will help users/applications. These entries are derived from INSPIRE code lists
{authority}	/bwsp.eaew This segment shows that the data is sourced from the Environment Agency and since the EA use similar identifiers across several datasets a subnamespace extension —bwsp.‖ is added to denote the source dataset. This represents a key part of the namespace of the INSPIRE unique object identifier. In practice, the namespace will typically be the URI up to and including the authority information.
{localid}	/36800 This represents the local identifier part of the INSPIRE unique object identifier. This is part of the identifier of the spatial object - not of the real world phenomena.
{version}	The resource may also be versioned, to reflect the state of the object at different times. This is optional and not used in the example above. Default should be the latest version.

1.2. Land Registry and Cadastre Parcel Inquiry Application

Land registry and cadastre information about the immovable properties in Turkey are recorded by TKGM and made available for the users. Making use of web technology for the presentation of information about the immovable properties [23,24], TKGM put into practice many applications to render service to the citizens. One of these services is parcel inquiry system made available through the following https://parselsorgu.tkgm.gov.tr/address. It is aimed with the application, inquiry of parcel information held in the data base by the users. Entering the key words (e.g., province, town, district, block, parcel information) that belong to the related parcel, Users can access to location, area, type information for the parcel. Performance of desired inquiry is based on correct data entry by the user for the related parcel. However; it may result in several incorrect inquiries which are difficult to be recognized if the user enters preliminary information about the parcel (manually) on its own. For instance the user may select block number as 102 instead of 101; or parcel number as 6 instead of 5 and as a result information about the parcel will be displayed on the result screen if there is such a parcel in the in the database, for which incorrect information has been entered. Thus, the user will have reached the information about the parcel for which incorrect information has been entered instead of the actually desired parcel and he may not be aware of this. Inquiries performed on the database are generally carried out

through key words specifying data content. Incorrect selection of such predetermined key words may lead to incorrect inquiry results. General Directorate of Land Registry and Cadastre renders parcel inquiry service through the following address: https://parselsorgu.tkgm.gov.tr/. Basic information that belongs to cadastre information, harmonization of which with land registry has been completed under MEGSİS is presented with this application. Parcels, land registry and cadastre information of which were matched under the Project are held in the database upon classification based on the information about province, town, and district/village, block and parcel number. Inquiry is performed by entering some preliminary information about the parcel and drawing the desired information from the database. Entering some fundamental information about the parcel (Province, Town, District/Village, Block and Parcel), citizens are able to access information with the inquiry about the location of parcel (satellite vision integrated onto Google maps) and area and type of the parcel (Figure 3).
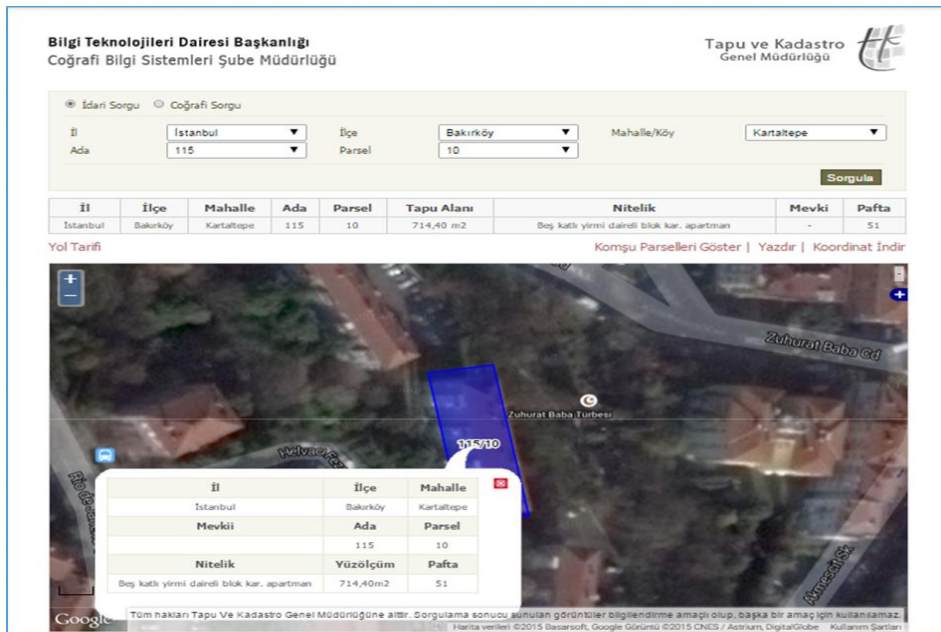

Figure 3. Cadastre Parcel Inquiry user interface [12].

Performance of desired inquiry is based on correct data entry by the user for the related parcel. However; it may result in several incorrect inquiries, which are difficult to be recognized if the user enters preliminary information about the parcel (manually) on its own. In this respect, it is aimed with the inquiry method, suggested in the study to eliminate user mistake and perform faster and more practical inquiry.

1.3. QR Code Technology Overview

Quick Response-QR code is a special matrix barcode (or 2-d barcode) type which can be read by the cams of mobile devices. Developed in 1994 by Denso, a Japanese company, the code generally consists of black patterns on square white background. Analysing the recorded image, barcode content may direct the user to e.g., an internet address, e-mail address, telephone number, contact information, SMS or MMS or information about geographical location. Basing

on Near Field Communication-NFC, quick response code technology is designed to establish contactless and reliable communication in a very short time between the electronic devises in close distances [13, 14].

QR Code Generation: Many web sites render QR code generation services in web environment free of charge. For instance, quick response code generation screen that belongs to following web site: http://www.qrcode-generator.com/ is displayed in Figure-4. Quick response code generation process consists of three steps in general. In the first step, the type of the QR code is selected. In the second step, selected type of QR code s copied (e.g., URL address). And in the third step, related content is converted into quick response format by pressing on ''Generate QR code'' button and it is displayed on the screen (Figure-4). Generated QR code can be downloaded in several formats (e.g., JPG, EPS, SVG).
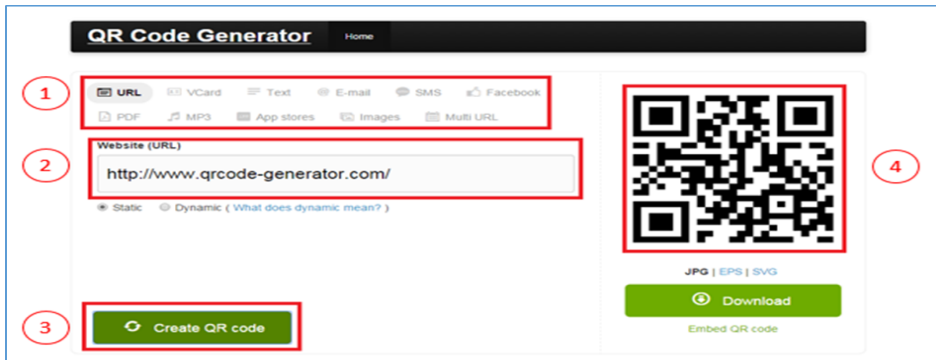
Figure 4. QR code creating user interface [15].

Data Capacity of QR Code: Type and maximum capacity of data to be coded into QR code content is presented into Table 2.

Table 2. Maximum character storage capacity of QR code [16].

Input mode	max. characters	bits/char	Possible characters, default encoding
Numeric only	7,089	$3\frac{1}{3}$	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Alphanumeric	4,296	$5\frac{1}{2}$	0–9, A–Z, space, $, %, *, +, -, ., /, :
Binary/byte	2,953	8	ISO 8859-1
Kanji/kana	1,817	13	Shift JIS X 0208

Scanning QR Code: Murkute et al., [17] describe scanning process of quick response code one by one in the following paragraph (Figure 5).
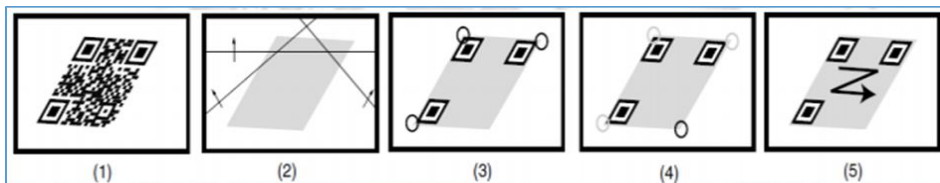
Figure 5. QR code scanning steps [17].

In the first step, grey level is calculated; in the second step, marked triangular point is detected by detector; in the third step, the fourth corner is estimated with the help of special

algorithms; in the fourth step, inverse transformation is ensured in order to normalize code length making use of current corner points; and in the final step the code is decoded by performing scanning.

In order to be able to use QR code technology, it is required to have communication instruments with internal camera feature and quick response code reader applications [18]. QR code can be analysed quickly by the application installed on the device (Figure-6). Thus, the users are able to see the information encoded within the QR code on the screens of the devices. Once the decoding operation takes place, the user is able to send short text message (SMS) or access a text encoded in quick response code just as he could be directed to mobile web pages [19]. The user can decode a QR code in three steps and displays the content thereof. In the first step, QR code is scanned through a device with QR code application; in the second step, the password in the QR code is decoded and in the third step primary content is accessed going through the source of decoded content (Figure-6).

Figure 6. Accessing QR code context [20].

1.4. QR Code - URI Relation

An URL address can be coded in to QR code as well as applications such as text, sms or e-mail. When the URL address encoded in QR code is decoded, the page for this URL address can be displayed (Figure 5). Thus, a more practical access to URL address has been ensured with the QR code instead of writing the URL address. URL is a subset of URI (Figure-7). In addition to source identification feature of URI, URL further adds a presentation of the source or the location of such on a network [7]. For instance, it is an URI that identifies the source of http://www.qrcode-generator.com/qrcode-genator, it is at the same time an URL as the source is a HTML presentation. This is why, URI addresses can also be encoded into QR codes just as URL (Figure 8).
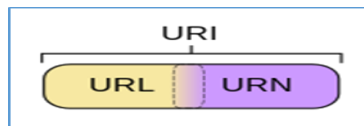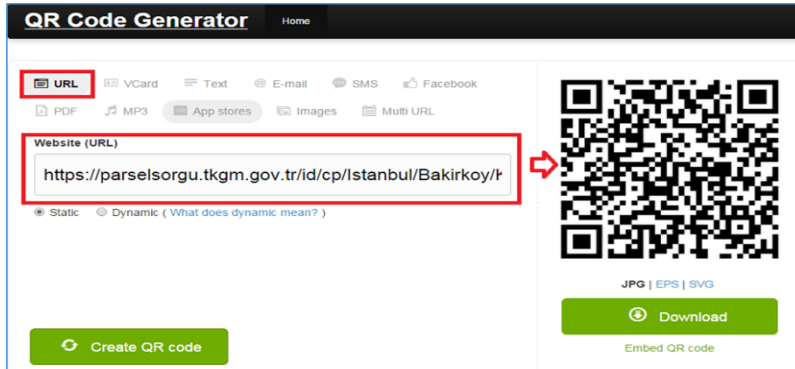

Figue 7. URI componet [21].

Figure 8. Creating QR code steps with URI context [15].

2. MATERIAL AND METHOD

In order to put the application into practice, it is essential that a QR code be imprinted on land certificate. During the application, URI addresses, one for each, peculiar to each parcel was defined by taking INSPIRE URI model as a reference with the key concepts (City, Province, Town, Block and Parcel Number) in the parcel database regarding current parcel inquiry application. In order to be able to ensure access to the defined URI address without entering preliminary information, QR code technology was utilized. The application consists of four stages: (1) Creating URI address, peculiar to parcels, (2) Generating QR code of created URI, (3) Imprinting generated QR code with URI content on the land certificate for the related parcel, (4) Access of user to the web page where the information about related parcel is included upon decoding of the QR code on the land certificate by the user. The first three stages are the phases before the user and involve making the application available for the user. The final stage is the user stage. Each stage is described in detail one by one as follows:

2.1. Creating URI

In general, characteristics expected from URI addresses are that they are stable, trackable, connected to each other, short but informative, and human readable [7, 10, 22]. Considering the mentioned features and INSPIRE URI model, an URI, peculiar to each parcel, registered in parcel inquiry system was defined. Match-up of defined URI model and INSPIRE URI model is presented in Figure 9.
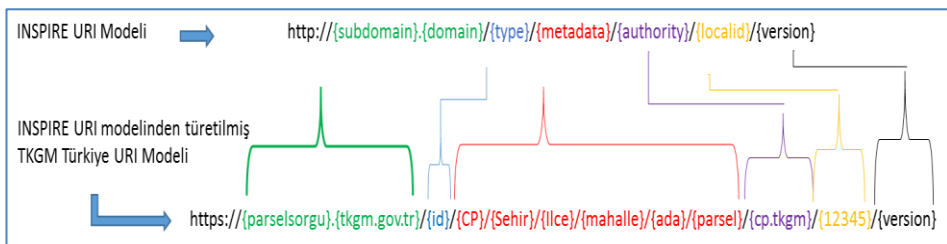
Figure 9. TKGM Turkey URI model defined with reference to INSPIRE URI model.

When the Province, Town, District/Village, Block and Parcel information of parcels registered in database are selected one by one, this functions as a key ID for that parcel and enables to perform related inquiry. This is why URI addresses, which were generated by using the metadata for that parcel (province, town, and district/village, block and parcel information), have changed into an original URI address for each parcel. According to the recent URI model created in compliance with INSPIRE URI model, the URI address regarding parcel no. 10 at block no. 115 in Kartaltepe district, Bakırköy town, and Istanbul province shall be as follows: https://parselsorgu.tkgm.gov.tr/id/cp/Istanbul/Bakirkoy/Kartaltepe/115/10/cp.tkgm/12345. As stated in this example, similar URIs may be generated for each parcel in the database. Description of address components in the suggested URI model is presented in Table 3.

Table 3. Specifications abaut suggested Turkey URI model

A spatial object URI	https://parselsorgu.tkgm.gov.tr/id/cp/Istanbul/Bakirkoy/Kartaltepe/115/10/cp.tkgm/ 12345
{subdomain}, {domain}	http:// parselsorgu.tkgm.gov.tr Name of domain and subdomain used for parcel querying application by TKGM.
{type} of resource	/id This denotes that the resource is a spatial object
INSPIRE {metadata}	/cp/Istanbul/Bakirkoy/Kartaltepe/115/10 This denotes metada about parcel Cp: Abbreviation code related to INSPIRE Cadastral Parcel Identification Code İstanbul: The province where parcel. Bakırköy: The town where parcel. Kartaltepe: The district/village where parcel. 115: Block number where parcel. 10: Parcel number.
{authority}	/cp.tkgm This donetes authority which manage the application. CP: INSPIRE Cadastral Parcel Code tkgm: This denotes application authority.
{localid}	/12345 /12345: This represents the local identifier part of the INSPIRE unique object identifier and defined by authority.
{version}	Name of version of application.

In Table 4, URI addresses regarding the parcels selected from different regions, which were identified on the basis of INSPIRE URI model were listed as a sample. Cited URI addresses are not active since they are defined for suggestion purposes. Province, town, district/village, block and parcel Information about each parcel in ''Parcel Information'' column of the Table is provided so that it could be recognized which parcel the identified URI belongs to. Users are not required to enter such information while they are making inquiry with QR code. Such information will already be accessed as a result of the inquiry.
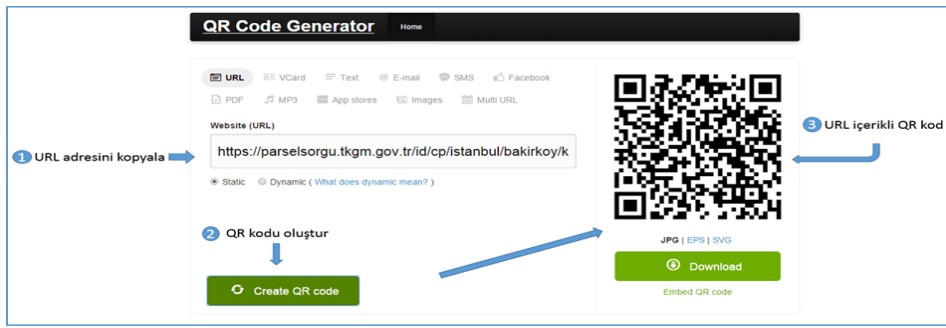
2.2. Generating QR Code with URI Content

URI addresses for each parcel identified in the previous stage may be converted to QR code with URI content thanks to many free QR code generating application. First of all, ''generate URL'' feature of QR code application is selected to do so (Figure 10). Then, the defined URI address is copied in the related field (Figure 10) and QR code for the related URI address is generated by pressing ''generate QR code'' button (Figure 10). Likewise, QR codes with URI content may me generated for each parcel in the database.

Table 4. Example of parcel URI addresses related suggested Turkey URI model

Parcel Information					URI address*
Province	Town	District	Block	Parcel	
Istanbul	Bakirköy	Kartaltepe	115	10	https://parselsorgu.tkgm.gov.tr/id/cp/Istanbul /Bakirkoy/Kartaltepe/115/10/cp.tkgm/12345
Ankara	Cankaya	Akpınar	25893	6	https://parselsorgu.tkgm.gov.tr/id/cp/Ankara/ Cankaya/Akpınar/25893/6/cp.tkgm/3455523
Izmir	Bergama	Atmaca	310	1	https://parselsorgu.tkgm.gov.tr/id/cp/Izmir/B ergama/Atmaca/310/1/cp.tkgm/3452290
Bursa	Kestel	Aksu	105	5	https://parselsorgu.tkgm.gov.tr/id/cp/Bursa/ Kestel/Aksu/115/5/cp.tkgm/6345266

* URI addresses defined in this study for application purposes are not active as they are symbolic addresses generated based on TKGM parcel inquiry application.

Figure 10. Creating QR code steps with URI context.

QR code with URI content, generated for each parcel may be imprinted on the land certificate of the parcel (Figure 11). Thus, the user may be able to access the web page including the information about the related immovable property (location, possession etc.) by decoding the QR code on the land certificate.

Figure 11. Example of title deed printed QR code

2.3. Parcel Information Inquiry through QR Code with URI Content

Generated QR codes with URI content may be imprinted on the land certificate of related immovable property (Figure 11). When the person with the land certificate on which QR code was imprinted, swipes and decodes the QR code on the land certificate by means of any instrument with code application (smart phone, camera etc.), he may be able to access the web page for the related parcel (Figure 12).

Figure 12. Scanning title deed printed QR code and accessing related URI address.

3. FINDINGS AND COMPARISON

Current parcel inquiry application of TKGM can be implemented in six steps by selecting the information about the parcel one by one. However, the suggested QR code with URI content inquiry application takes place in two steps without entering the information about the parcel (Figure 13). As there is no information entry in the suggested application, incoorect inquiry by the user would be prevented. When two applications are compared, Parcel inquiry application through QR code with URI content is more advantageous in terms of safety and practicality (Table 5). Both applications are compared in Table 5 in terms of their characteristics.
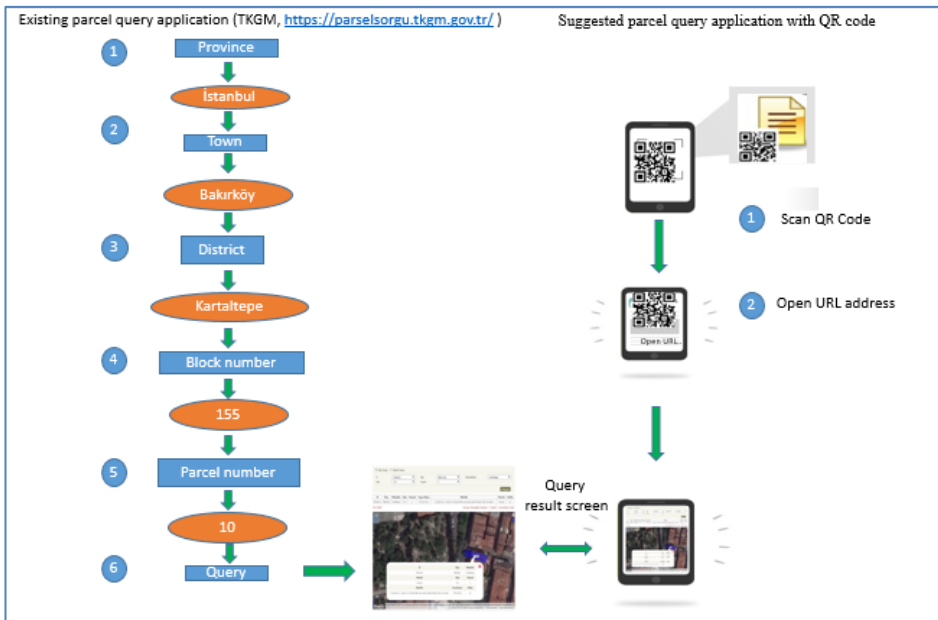

Figure 13. Comparison of the proposed querying application via QR code with the existing parcel querying application.

Table 5. Comparison of two applications in terms of their characteristics.

Criteria	TKGM Parcel Query Application	Suggested Parcel Query Application with QR Code
Query time	Approximately 30 seconds	Approximately 5 seconds
Incorrect query	Possible	Impossible
Practical use	Six steps inquiry	Two steps inquiry
Preliminary information entry for query	Required	Not required

4. RESULT AND DISCUSSION

URI applications become more of an issue within the context of INSPIRE that consists many data and web infrastructure regarding European Union for which Turkey is under membership process. Here it is important that Turkey uses INSPIRE URI as a basis and evaluate what could be done in consideration of this main theme. In this respect, an inquiry application is designed in this study that could be an alternative for parcel information inquiry application offered by TKGM. In the application, an URI has been identified specific to each parcel based on INSPIRE URI model. Access to web pages including the information about related parcels has been ensured thanks to the defined URIs. QR code technology is used for ensuring access to web pages regarding the related parcels without a requirement by the user to enter preliminary information. With the QR codes generated with URI content, users are directed to related web pages regarding the parcels. Preventing preliminary information entry by the users during the inquiry thanks to the application, the risk of performing incorrect inquiry has been eliminated. Inquiry performed with the application (inquiry in two steps) is more practical than the current parcel inquiry by TKGM and takes a shorter time (ca. 5 seconds). Furthermore, the use of URIS may gain favours other than inquiry purposes in several fields to identify, monitor spatial objects and allow for reuse of such and to establish connections with other data sets.

Remarks

URI addresses (Table 4) defined in this study for application purposes are not active as they are symbolic addresses generated based on TKGM parcel inquiry application.

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