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QR VERIFICATION OF LABORATORY STUDIES RESULTS

Abstract. This article describes the practical using of QR codes [1] verification of laboratory studies results. QR codes have become widely used in all industries as quick identification of information and the implementation of transactional actions, where encrypted URL allows to quickly scanning by using a smartphone camera. Digitalization contributes to the transition to the online environment of healthcare, office workers, education and to receive more data on the spread of diseases, exchange information and quickly receive laboratory results without distortion. The presented solution is a component of the LIS SmartLAB platform [2], which performs complex automation of laboratories of the different profiles, observing all work processes to obtain reliable results by direct interaction with laboratory equipment according to international standards HL7 (Health Level 7 - "Seventh level"), ASTM (American Society for Testing and Materials - "American Society for Testing Materials") and automatic detection of deviations from standard values [3]. In 2019, there was a pilot implementation of QR verification of results based on the laboratory of the Skin and venereal dispensary of the Almaty, the results of which made it possible to introduce QR codes into other profiles of laboratory diagnostics, such as PCR (polymerase chain reaction), genetics, microbiology and clinical diagnostics. Now, due to the pandemic, all laboratory results for the detection of RNA of the COVID-19 virus must contain a QR code to avoid falsification of the results.

Key words: QR codes, laboratory information system, laboratory studies, Covid-19, laboratory results verification, information system.

Introduction. State program "Digital Kazakhstan" implemented in the period from 2018 to 2022 is a strategic comprehensive program that aims to improve the living standards of the country's population through the use of digital technologies [6]. Within the scope of the program, special attention is paid to the large-scale implementation of the electronic health passport of the population of the Republic of Kazakhstan, where the automation of clinical diagnostic laboratories plays an important role. Within the framework of the Digital Kazakhstan program, especially in terms of laboratory analyzes of an electronic health passport, since 2018, the use of QR verification of laboratory research results has begun, where special attention paid to protecting laboratory research results from counterfeiting. The solution implemented on the platform of the laboratory information system SmartLAB, where QR codes applied to the forms of laboratory research results in an automatic mode. The results were verified through the online results verification service.

A QR code is a two-dimensional barcode (2D barcode) that can contain various information. QR stands for "Quick Response", which reflects the ability of devices and software to quickly recognize the code and convert the data into a barcode. DensoWave developed the QR code in Japan in 1994 for encoding various service information. One QR code can include the following maximum number of characters:

- Numbers – 7089;
- Numbers and letters (including Cyrillic) – 4296;
- Binary code – 2953 bytes;
- Hieroglyphs – 1817.

Currently, the QR code is widely distributed in Asia, Europe, and North America. In Japan, such codes are very popular and are applied to almost all products. The use of QR codes has gained particular popularity in the banking sector. For example, in China, The most common payment scheme based on QR codes is the use of WeChat Pay (a payment system for making payments using the WeChat messenger, owned by Tencent) and Alipay (one of the largest payment systems that are part of Alibaba Group). In 2016, payments and transfers were made through a QR code worth $ 1.65 trillion in China, which is about a third of all mobile payments in the country [7]. In Kazakhstan, the QR code became popular after the launch of the Kaspi QR service, which provided a secure service in the Kaspi.kz mobile application [8].

The forms of laboratory research results published in this article are impersonal and presented without the personal data of patients, to avoid publication of personal data of patients, which protected by the law on personal data [9].

Main section. The study aims to implement a system to protect laboratory test results from counterfeiting, especially if these are the results of skin and venereal diseases or COVID-19. As everyone knows, the Covid-19 pandemic continues, and according to statistics, the situation in Kazakhstan and the world is not stable (figure 1) [10].

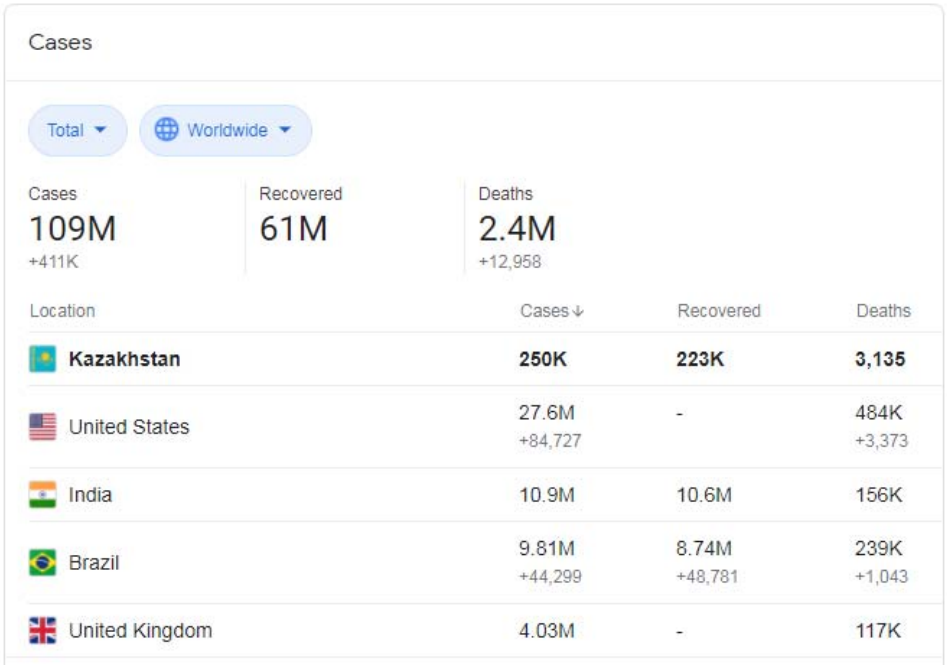

Figure 1 - Covid-19 statistics at 20.01.2021

According to statistics, it is necessary to protect against falsification of laboratory test results so that unscrupulous citizens cannot spread and multiply the SARS-CoV-2 virus.

The implementation of this solution consists of the following stages:

- Stage 1. Development of the model of the system;
- Stage 2. Development of libraries for generating QR codes and putting them on the results forms;
- Stage 3. Development of an online service for QR code verification;
- Stage 4. Publication of the service for production use.

Stage 1. At this stage, the processes were defined, the steps of the interaction of each process, areas for verification of the authenticity of the research results, as well as the format of the returned information, where it was clearly defined that:

- Data exchange with using JSON;
- Electronic results in PDF format, since it is a universal convenient format for presenting information.

As a result, the model was presented as in figure 2.

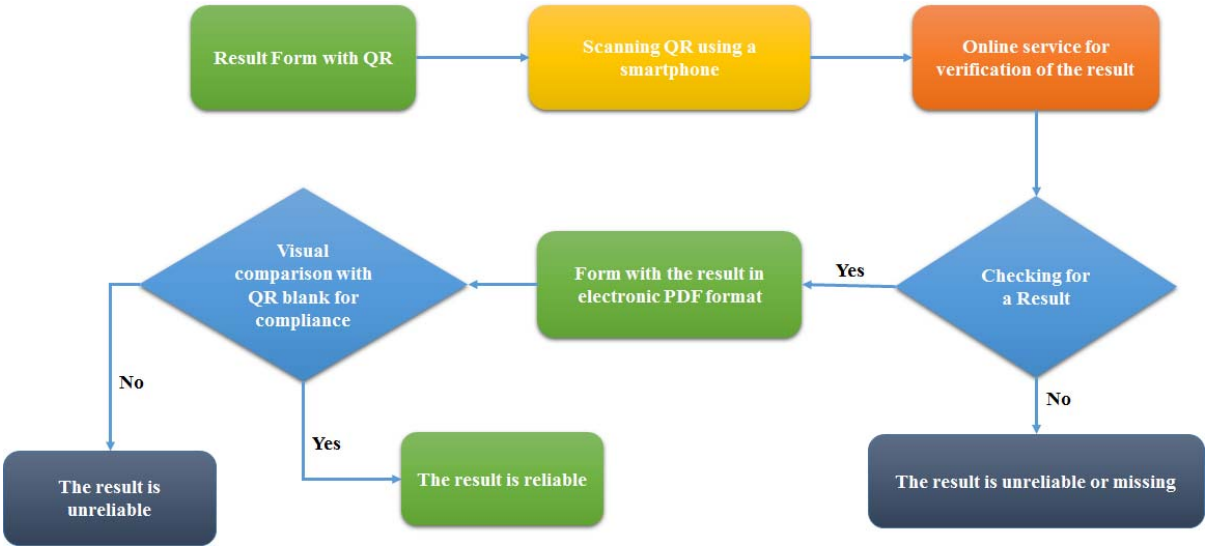

Figure 2 - General solution model

Stage 2. At this stage, the development of methods for generating a QR code with its further application to the results form carried out. A result form is a form of medical documentation approved by the Ministry of Health of the Republic of Kazakhstan, which contains the following information (figure 3):

Қазақстан Республикасы
Денсаулық сақтау министрлігі
Министерство здравоохранения
Республики Казахстан

Ұйымның атауы:
Наименование организации:
ШЖҚ «Teрi-венерологиялық диспансер» МКК
ГКП на ПХВ «Кожно-венерологический диспансер»

70209656

Қазақстан Республикасы
Денсаулық сақтау министрінің м.а. 2010 жылғы
"23" қарашадағы № 907 бұйрығымен бекітілген
№ 224/е нысанды медициналық құжаттама
Медицинская документация. Форма №224/у
Утверждена приказом
и.о. Министра здравоохранения Республики
Казахстан от "23" ноября 2010 года № 907

ҚАН ТАЛДАУЫ
АНАЛИЗ КРОВИ (микрореакция)

Тегі А.Ж. (Ф.И.О.):		
Туған күні (Дата рождения): 01.05.1997	Жынысы (Пол):Ж.	ЖСН (ИИН):
Мекен-жайы (Адрес):		
Диагноз:		
Ұйым (Организация):ГКП на ПХВ "Кожно-венерологический диспансер" УЗ г. Алматы		
Бөлімше (Отделение):		
Дәрігер (Врач):		
Биоматериалды алу мерзімі (Дата и время взятия биоматериала):		
Жолдаманы тіркеу мерзімі (Дата и время регистрации заявки):	15.01.2021 09:10	

Компоненттер, элементтер Компоненты, элементы	Нәтижелер Результаты	Қалыпты мәлшер Нормативные величина
Кардиолипинді антигені бар преципитация микрореакциясы *Микрореакция преципитации с кардиолипиновым антигеном*	Теріс *Отрицательно*	Теріс *Отрицательно*

Талдаудың орындалуы жайлы ақпарат / Информация об исполнении исследования	
Нәтижені қалыптастыру мерзімі (Дата и время готовности результата):	15.01.2021 09:23
Орындаушы (Исполнитель):	

«Teрi-венерологиялық диспансер» / «Кожно-венерологический диспансер»
ҚР, Алматы қ., Манас көш., 65 /РК, г. Алматы, ул. Манаса, 65, тел.:+7 727 274 01 95, вн.105

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Figure 3 - Result form

To generate a QR code for the results form (figure 3), a built-in component in the LIS Smartlab platform was used. The QR code was generated by the URL (Uniform Resource Locator - a system of unified addresses of electronic resources) the address of the online service indicating the unique GUID (Globally Unique Identifier - the globally unique identifier) key as a verification parameter. The QR code URL received the following form: “https://online.service/?Lab_order=ABF90471-1403-4496-863E-

8ACA855A51F6". The key was generated automatically when creating an order for laboratory research and was used for further identification. As a result, the model for the implementation of the 2nd stage received the following form (figure 4):

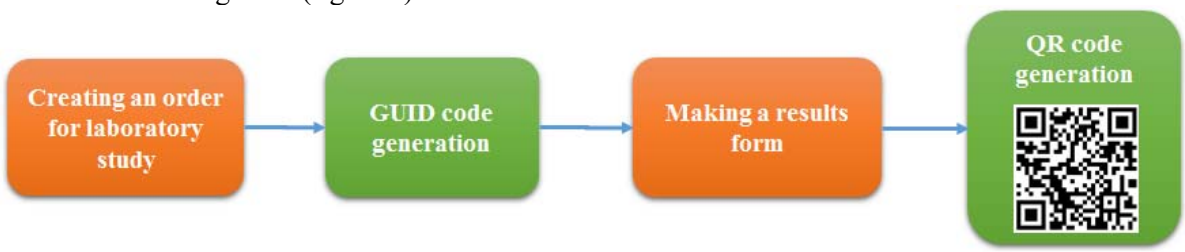

Figure 4 - QR code generation model diagram

Stage 3. At this stage, the development of an online service carried out, which produces the following work:

- Development of methods for identifying a unique code transmitted via a QR code.
- Development of API methods for verifying the result;
- Adaptation of the PDF viewer of the results to the service, since when the results are directly displayed in PDF format on smartphones, the file is available for viewing after downloading to the device;
- Development of methods for displaying the obtained result.

When developing a method for displaying the results, external factors were taken into account, such as robots and bots that can constantly scan hosts and load the service. To avoid this, Google ReCaptcha (a system of protection against Internet bots) [11] was activated, which further increased the protection of the service. When switching to an online service, a page for checking for Internet bots is displayed in front of the user (figure 5), which will not allow switching to verification of the result without checking for bots.

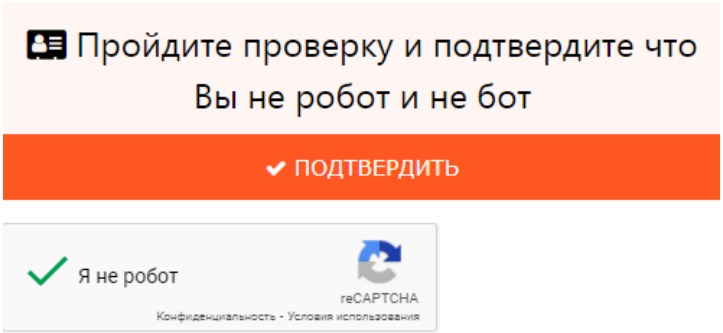

Figure 5 - Checking for Internet bots

The service and all methods developed by using the PHP 7.4 programming language, the Nginx web server. As a result, the service received the following model of work (figure 6.):

Figure 6 - Service model

Stage 4. At this stage, the solution was tested, finally, QR codes for verification were automatically generated in all forms of results and published for identification in the online service. For participants in the laboratory automation process, their local online services are created, which allows you to distribute the load. As a result, the scheme of the solution was as follows (figure 7):

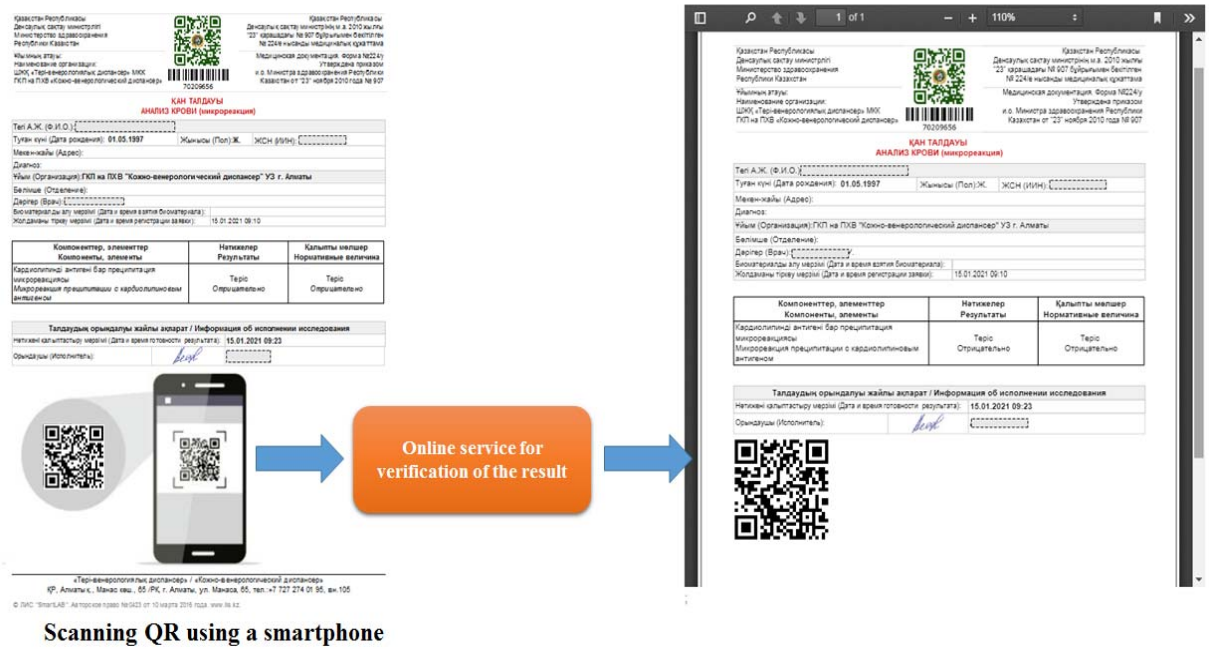

Figure 7 - Solution in production mode

Results. The presented solution passed production testing in February 2019 at the "Dermatovenerologic dispensary" in the Almaty and widely used for other laboratories of the public and private sectors.

Conclusion

QR coding of laboratory test results is an integral part of LIS SmartLAB results forms, and has been implemented in laboratories of various profiles, such as “Kazakh Research Institute of Eye Diseases (Almaty), Kapshagai City Clinical Hospital (Kapshagai), Center for Molecular Medicine (Almaty, Nur-Sultan, Atyrau), Center for Sports Medicine and Rehabilitation (Almaty), Almaty Regional Children's Clinical Hospital (Otegen-Batyr village, Almaty region), KazNMU named after S. D. Asfendiyarov (Almaty), MEDSI LLP (Karaganda), GioTrade LLP (Karaganda), Regional Center for Reproductive Medicine (Ust-Kamenogrsk). I would like to note that the presented solution served as one of the tools to protect against falsification of the results for COVID-19, which influenced the publication of the order by the Ministry of Health of the Republic of Kazakhstan on the forms of results for Covid-19. As a result, the participants in the automation process achieved:

- The reliability of the results - the result on paper could always be verified for reliability;
- Application by laboratories of various profiles, including PCR for Covid-19.

The materials presented in this article are the result of the practical application of solutions in the field of laboratory diagnostics automation.

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ЗЕРТХАНАЛЫҚ ЗЕРТТЕУЛЕР НӘТИЖЕЛЕРІНІҢ QR-ВЕРИФИКАЦИЯСЫ

Аннотация. Бұл мақалада зертханалық зерттеулер нәтижелерінің шынайылығын тексеру үшін QR кодтарын [1] практикалық қолдану сипатталғады. QR кодтары барлық салаларда ақпаратты жылдам сәйкестендіру және транзакциялық әрекеттерді жүзеге асыру ретінде кеңінен қолданыла бастады, мұнда URL мекен-жайын шифрлау қолданылып, смартфон камерасы арқылы жылдам анықтауға мүмкіндік береді. Цифрландыру денсаулық сақтау, жұмыс, білім берудің онлайн-ортасына көшуге және аурулардың таралуы туралы көбірек мәліметтер алуға, ақпарат алмасуға және зертханалық нәтижелерді бұрмалаусыз тез алуға ықпал етеді. Ұсынылған шешім SmartLAB лабораториялық ақпараттық жүйесінің платформасының құрамдас бөлігі болып табылып [2], әр түрлі профильдегі зертханаларды кешенді

автоматтандыруды HL7 (Денсаулық деңгейі 7 - «Жетінші деңгей») [3], ASTM (ағыл. American Society for Testing and Materials - «Американдық тестілеу материалдары қоғамы») [4] халықаралық стандарттарына сәйкес зертханалық жабдықтармен тікелей өзара әрекеттесу арқылы сенімді нәтижелерге қол жеткізу үшін барлық жұмыс процестерін қадағалай отырып, стандартты мәндерден ауытқуларды автоматты түрде анықтауды жүзеге асырады [5]. 2019 жылы Алматы қаласының тері – венерологиялық диспансерінің зертханасы негізінде QR кодтарын пилоттық енгізу жүзеге асырылды, оның нәтижелері жағымды әсер беріп, QR кодтарын басқа зертханалық диагностиканың профилдерінде, мысалы ПТР (полимеразды тізбекті реакция), генетика, микробиология және клиникалық диагностикада енгізуге мүмкіншілік берді. Қазіргі уақытта, пандемияға байланысты, COVID-19 вирусының РНҚ-ын анықтауға арналған барлық зертханалық нәтижелер QR кодын қамтуы керек.

Түйін сөздер: QR-кодтар, зертханалық ақпараттық жүйе, зертханалық зерттеулер, Covid-19, зертхана-лық нәтижелерді тексеру, ақпараттық жүйе.

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QR-ВЕРИФИКАЦИЯ РЕЗУЛЬТАТОВ ЛАБОРАТОРНЫХ ИССЛЕДОВАНИЙ

Аннотация. В данной статье описывается практическое применение QR-кодов [1] для проверки достоверности результатов лабораторных исследований. QR-коды стали широко использоваться во всех отраслях в качестве быстрой идентификации информации и осуществления транзакционных действий, где с их помощью производится шифрование URL-адреса, что позволяет быстро его сканировать при помощи камеры смартфонов. Цифровизация способствует переходу в онлайн-среду здравоохранения, трудовой деятельности, образования и получать больше данных о распространении заболеваний, обмениваться информацией и оперативно получать результаты лабораторных исследований без искажений. Представленное решение является компонентом платформы ЛИС SmartLAB [2], который производит комплексную автоматизацию лаборатории разного профиля, соблюдая все рабочие процессы для получения достоверных результатов путем непосредственного взаимодействия с лабораторным оборудованием по международным стандартам HL7 (англ. Health Level 7 – «Седьмой уровень») [3], ASTM (англ. American Society for Testing and Materials – «Американское общество по испытанию материалов») [4] и автоматическому выявлению отклонений от нормативных величин [5]. В 2019 году было пилотное внедрение QR-верификации результатов на базе лаборатории кожно-венерологического диспансера г. Алматы, результаты которого дали возможность внедрения QR-кодов и в другие профили лабораторной диагностики, такие как ПЦР (полимеразная цепная реакция), генетика, микробиология и клиническая диагностика. В настоящее время в связи с пандемией все результаты лабораторных исследований на выявление РНК-вируса COVID-19 должны содержать QR-код во избежание подделок результатов.

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