A Comment on the Problem of the QR Code Used in Early-voting[1]

1. Preface

Controversy continues over the early-voting of the April 15th general election, which recorded the highest turnout ever. It was controversial that the National Election Commission used QR codes on early-voting ballot papers instead of barcodes as prescribed by the Public Official Election Act. The Public Official Election Act mandates the use of barcodes on early-voting ballot papers. Hereinafter, we will look at the definition of the QR code and related issues.

2. Barcode and QR code

I would like to explain in detail the “QR Code” that violates the Public Official Election Act, compared to a “Barcode”.

2.1 Barcode definition

A barcode is collectively referred to as the medium for visual recognition using various patterns and colors, including one-dimensional barcodes (UPC/EAN, Code128, Code39, Codabar, etc.) and two-dimensional barcodes (InterCode, Data Matrix, PDF417, color code, QR Code, etc.). The type and standardization of barcodes are not specified here. [2]

2.2 Definition of QR Code (Quick Response Code, QR Code)[3]

A QR Code refers to a code in the form of a matrix that represents information in a pattern. 'QR' is an acronym for 'Quick Response'. It can contain 1700 Korean characters or 8000 numbers, and is used by reading it with a digital camera or a dedicated scanner. It can be used for free due to being adopted as an international standard (ISO/IEC 18004). QR Code is a registered trademark of the DENSO WAVE company. It was developed by Denso Wave in Japan in 1994, and it is widely used in various fields as Denso Wave declared that it would not exercise its patent rights.

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[1] 21st General Election of National Assembly Members of the Republic of Korea, held on April 15, 2020, hereinafter referred to as “April 15th Fraudulent Early-Voting”

[2] Mobile Barcode System configured for compatibility with group standard TTAS.KO-06.0179 mobile RFID system

[3] https://www.doopedia.co.kr/doopedia/master/master.do?_method=view&MAS_IDX=101230001172183 , Doosan Encyclopedia QR code

2.3 QR code definition in ISO/IEC 18004: 2015

QR Code is a matrix symbology. The symbols consist of an array of nominally square modules arranged in an overall square pattern, including a unique finder pattern located at three corners of the symbol(in Micro QR Code symbols, at a single corner) and intended to assist in easy location of its position, size, and inclination.

2.4 Difference between barcodes and QR codes[4]

① Similarities

Barcodes and QR codes are both code numbering systems used to display electronic goods management indicating the product type, country name, and manufacturer name of an item or product.

② Differences

"Barcode" is a one-dimensional code system whereas "QR (Quick Response) code" contains information in two dimensions, and the storage capacity increases exponentially.

While conventional 1-dimensional barcodes can only store numeric information of around 20 characters, QR codes can store up to 7,089 numbers, up to 4,296 characters (ASCII), up to 2,953 bytes in binary (8 bits), and up to 1,817 Chinese characters. Recognition speed, recognition rate, and resilience are also better than general barcodes. If barcodes are mainly used for calculation, inventory management, and product verification, QR codes are often used as a means of marketing, promotion, and PR. **The crucial difference between the two is the amount of information stored**. This will be explained later.

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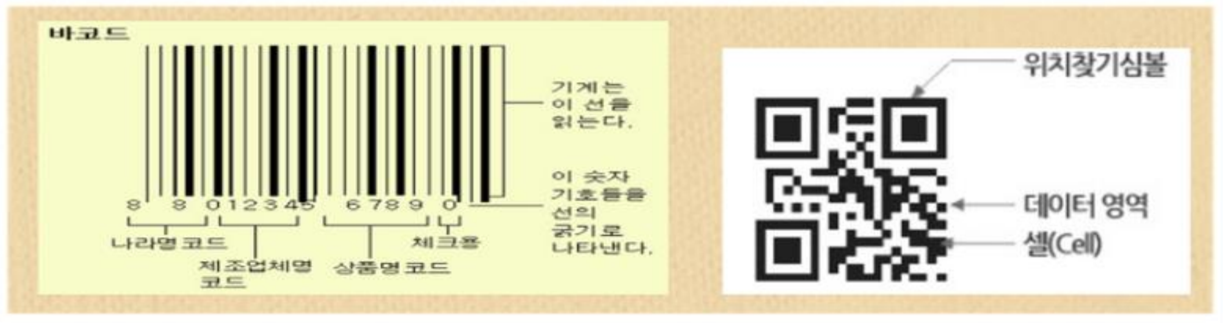
[4] https://en.wikipedia.org/wiki/QR_%EC%BD%94%EB%93%9C, QR code definition from Wikipedia



Barcode

Code for Country Name / Code for Manufacturer name / Code for Product name / for checking purposes / the numbers are shown through line thickness / the machine reads these lines

Symbol for finding location / Data Area / Cell

<Figure 1> A two-dimensional QR code whose storage capacity increases exponentially unlike a one-dimensional barcode

3. Risk of "QR Code" used in early-voting

3.1 The decisive difference between barcode and QR code (distinguishing profit)

Existing barcodes are basically one-dimensional configurations that can only contain numeric information of up to 20 characters in a horizontal arrangement. However, the QR code is **a two-dimensional structure that can record up to 7,089 numbers, 4,296 characters, and 1,817 Chinese characters using both horizontal and vertical arrangements.**

At best, barcodes can only record information like specific product names or manufacturers, but QR codes can contain long sentences of Internet addresses (URL), photo and video information, map information, and business card information.[5]

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[5] http://www.hwangryong.com/news/articleView.html?idxno=2472, Hwangryong.com

3.2 Benjamin Wilkerson's Opinion[6]

Benjamin Wilkerson also pointed out the dangers of QR codes as follows from an expert perspective.

① A Program can be inserted.

② The configuration of the Xilinx chip can also be changed.

③ It is possible to change the circuit inside the classifier.

3.3 Controversy about “QR code type” according to the number of digits (controversy about length of QR code)

QR codes also come in various forms depending on the number of digits. The processing range of information varies depending on whether there are 31 digits, 52 digits, or 77 digits. This is linked to a series of processes that include ① controversy over personal information infringement, ② inputting some kind of information in the QR code, and ③ manipulating the count. There is a controversy about this, so I want to explain it in detail.

3.3.1 31-digit claim

The figure (below) presented by the National Election Commission (NEC) as explanatory data revealed that it consists of 12 digits for the election name, 8 digits for the name of the constituency,

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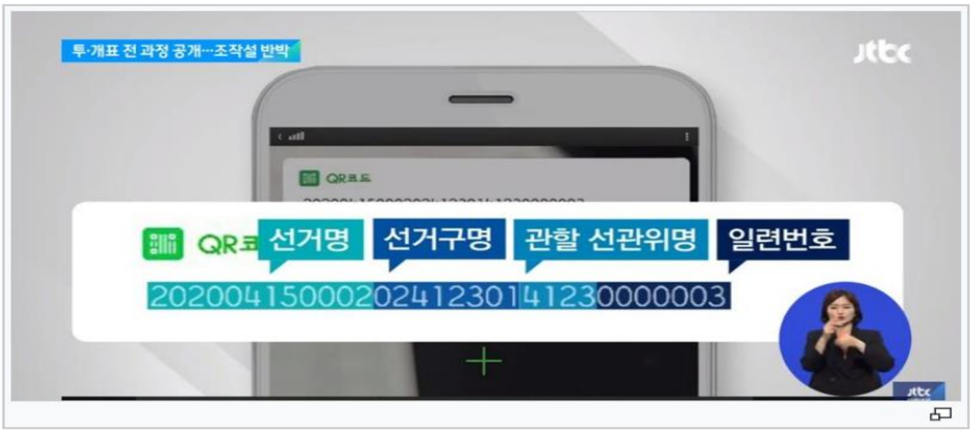
[6] https://www.youtube.com/watch?v=WGsUz9ZP7eM, [Shin Eui Hansu/Touch of God] “Benjamin Wilkerson, Sure of Rigged Election” Special Interview 2020.6.2.

4 digits for the name of the responsible NEC office, and 7 digits for the serial number.[7]


투·개표 전 과정 공개…조작설 반박
jtbc
QR코드
QR코
선거명
선거구명
관할 선관위명
일련번호
20200415000202412301412300000003
jtbc

Election name/ name of the constituency/ name of the responsible NEC/ serial number

<Figure 2> The 31 QR Code digits revealed by the NEC (Election name, name of the constituency, name of the responsible NEC, serial number)

3.3.2 52-digit claim[8]

The 31-digit claim has even spread to the existence of a “QR code sensor” in the ballot classifier. Min Kyung-wook, a former National Assemblyman of the United Future Party, said on May 19th, "We found out that communication equipment and a spectrum sensor that can read QR codes exists in the ballot classifier used in the general election through a report from a computer expert familiar with the internal affairs of the NEC."

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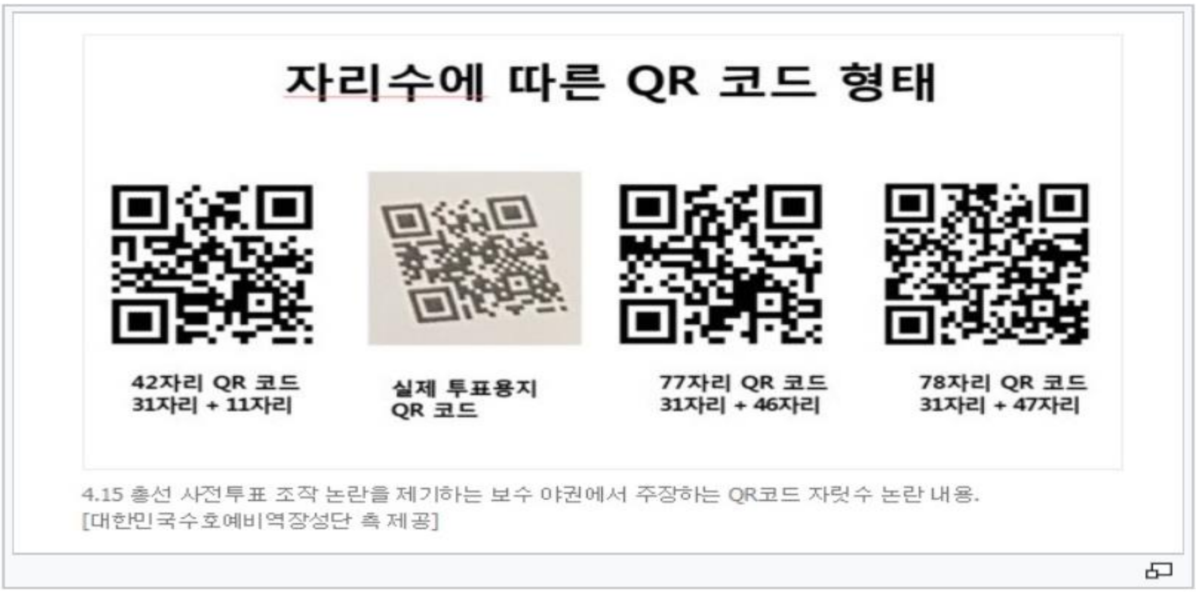
[7] https://www.NEC.go.kr/portal/bbs/list/B0000226.do?menuNo=200036, Explanation of the National Election Commission

[8] https://news.joins.com/article/23780922, [JoongAng Ilbo] This time,'QR code' election manipulation theory•••NEC "confused with the counting table"

“▶After putting some kind of information in the QR code (Step 1) ▶They read it with the ballot classifier sensor (Step 2) ▶ and the counting manipulation through the main server communication (Step 3) took place. This is the essence of the QR code controversy.”



4.15 총선 사전투표 조작 논란을 제기하는 보수 야권에서 주장하는 QR코드 자릿수 논란 내용.
[대한민국수호예비역장성단 측 제공]

QR Code Shape according to the number of Digits

42 Digit QR Code 31 Digits +11 Digits/ Actual Ballot QR Code/ 77 Digit QR Code 31Digit+46Digit / 78 Digit QR Code 31 Digit+47Digit

Contents of controversy over the number of digits of the QR code claimed by the conservative opposition that raised the controversy over the manipulation of the 4.15 general election early-voting. [Provided by the Republic of Korea's Guardian Reserve Generals]

<Figure 3> Different QR Code Shapes according to the number of Digits

3.4 Contents of the illegality of QR codes pointed out by the National Assembly in the past[9]

In October 2018, the National Assembly Administrative Safety Committee's report on “Settlement of revenue and expenditure account and approval of reserve expenditure under the National Election Commission for fiscal year 2017" said, "The QR code on the early-voting ballot differs from the definition of the barcode prescribed to use by the Public Official Election Act.

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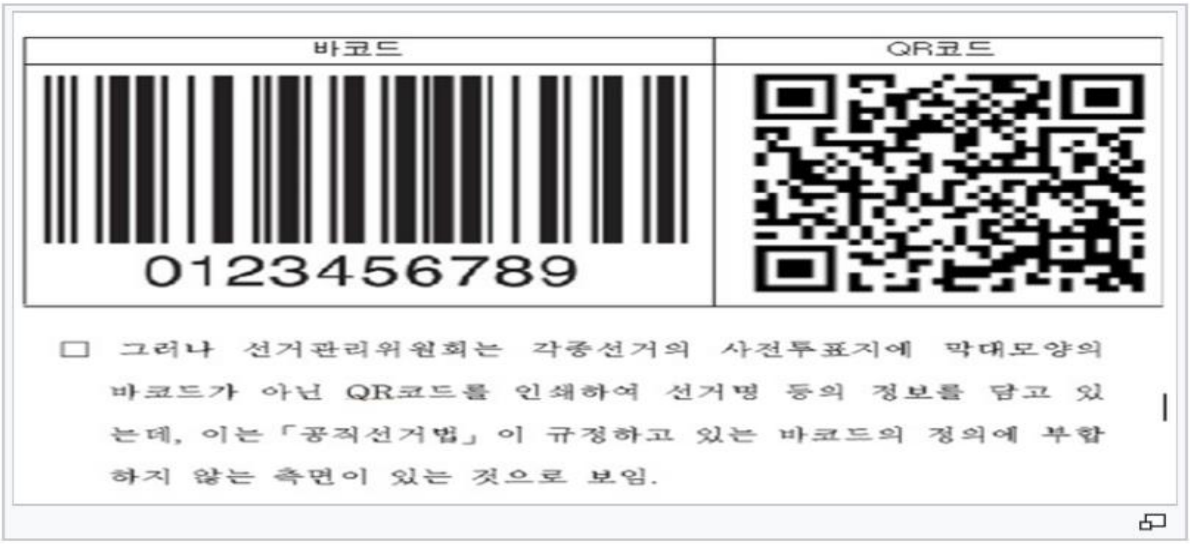
[9] http://www.newdaily.co.kr/site/data/html/2020/04/13/2020041300146.html, [New Daily] Election Act decided that "early-voting paper is barcode"... The NEC insisting on 'QR Code'


바코드
QR코드
0123456789

□ 그러나 선거관리위원회는 각종선거의 사전투표지에 막대모양의 바코드가 아닌 QR코드를 인쇄하여 선거명 등의 정보를 담고 있는데, 이는「공직선거법」이 규정하고 있는 바코드의 정의에 부합하지 않는 측면이 있는 것으로 보임.

However, the NEC prints QR codes rather than bar-shaped barcodes on early-voting papers for various elections to contain information such as election names, which seems to be inconsistent with the definition of barcodes stipulated by the [Public Official Election Act].

<Figure 4> In the report of the National Assembly in April 2018, it was pointed out that the display of the early-voting QR code is against the law.

In particular, the report said, "At the time of the 7th June 13th local election, when a netizen posted a question about the use of the QR code on the early-voting paper, the NEC accused the publisher of obstructing freedom of election and deleted the post."

Unfortunately, this was re-enacted at the April 15th general election early-voting. On the 2nd, the NEC accused four YouTubers who claimed that "the QR code printed on the early-voting paper contains the electoral personal information, so that you can check who you voted for", to the prosecution.

3.5 Amendment to the QR Code under the Public Official Election Act requested by the NEC to the National Assembly

Before the general election, the NEC urged the revision of the Public Officials Election Act on 2020.1.10. The NEC had made a request to prepare the basis for using the QR code on the early-voting paper. This also means that there is currently no lawful basis for using QR codes. In other words, they submitted an amendment because they realized that there was no basis for using the QR code on the early-voting paper.

3.6 Public Inquiry Form to the NEC (National Professors' Meeting)[10]

A civic group made the following public inquiries regarding the illegal and extralegal use of the QR code for the April 15th general election.

Therefore, We strongly condemn the use of QR codes while violating the prestigious regulations of the law, and openly inquire about the following matters as the NEC used QR Codes despite being fully aware that the use of QR codes other than barcodes on the early-voting paper in the 4.15 general election had no basis for use and that the reliability of the election process cannot be secured without revision of the law.

(1) The NEC will disclose whether any opinions have been received from the National Assembly regarding the use of QR codes in relation to the official document on January 10, 2020, and, if so, the contents (full text of the NEC's advisory and official on January 10, 2020).

(2) When was the first election committee-level decision made to use a QR code instead of a barcode during the early-voting of the 4.15 general election even though the Public Official Election Act was not revised for the basis of using the QR code, and who was the first drafter, interim approver, and final approver of this decision?

(3) Whether the use of the QR code has been dealt with at a full session of the NEC, and if so, a disclosure of the date and time of the meeting, the participants, the person who initiated or agreed to the agenda, and the decision-making process that led to the final decision to use it must be provided (disclose the minutes).

(4) Since there has already been "a lot of questions and complaints" due to the use of the QR code after the 2018 local elections, in this regard, the number, date and time of complaints received by the NEC as well as the status of processing should be disclosed

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[10] http://www.forjustice.kr/69/?q=YToyOntzOjEyOiJrZXl3b3JkX3R5cGUiO3M6MzoiYWxsIjtzOjQ6InBhZ2UiO2k6MTt9&bmode=view&idx=4050280&t=board , from Professors Wanting Justice in Society

(5) Regarding Paragraph 4, whether the NEC has held a full session meeting etc. to deal with legal and technical issues related to the use of QR codes, and if so, the minutes of the meeting should be disclosed.

4. A Detailed Review of the Risks of QR Codes

4.1 Risk of Personal Data Leakage through QR Codes

1) LG U+, the company that provided the communications equipment used in the elections, makes use of Huawei equipment despite warnings from the US. The current general advisor at Huawei, Lee Sang-cheol (1948), was the advisor of LG U+ from December 2015 to March 2017 after serving as the CEO and Vice Chairman at LG U+ beginning in 2010. He also served as the Minister of Information and Communication from 2002 to 2003 under Kim Dae-jung's regime. He has served as general advisor to China's Huawei at the same time as Moon Jae-in's inauguration.

2) By saying that a QR code will be generated before the early-voting ballots are issued means that the individual will each be assigned a ballot serial number.

3) When counting, the ballots are sorted by scanning the QR codes; however, this means that one will be able to know whose ballot voted for what, which violates the secrecy of the ballots.

4) All servers used China's Huawei equipment for communications. Whether data was leaked using the Huawei equipment as a backdoor is something that needs serious investigation.

4.2 Possibility of Ballot Count Manipulation using QR Codes

This is about the fact that manipulation would have been easy at the counter by using the QR codes to distinguish between early-voting and on-site ballots.

1) Not only do the ballot papers for the early-voting and the on-site elections need to be different, but there is also the need for a way to distinguish which votes are from early-voting with the counter. This was done by making the QR codes able to sort out the ballots. In other words, even if the ballots are mixed, the ballots sorted out by scanning the QR codes are recognized as early-voting ballots, therefore making it easy to distinguish between the ballots.

2) The data transmitted from scanning a QR code A) goes through the semiconductor backdoor of Huawei communications equipment; but B) by facilitating access from an intermediate server, C)

the algorithm can be run by a hacker or a program that wants to manipulate the data.

3) The counter used to scan the QR code is also important; in order to use the counter from Hantle System, which is the joint partner of the company that holds the copyright to Korea's Huawei smartphones and communications equipment, Chungho Comnet, the NEC filed for joint patent with Hantle in September and October of 2017.

4.3 The Risk of Qshing (QR+phishing)[11]

1) 'Qshing' (QR+phishing) is a criminal method in which the QR code is counterfeited to steal personal information. Practically the partner of SMiShing (SMS+phishing), the individual is baited by a text promising to give free coupons upon scanning the included QR code and thus induces the installation of a malicious code. At times, it directs victims to fake financial sites and requests money transfer or payments as well.

2) It is also possible to alter the QR code to adjust the frequency at which the malicious links are executed to bypass filtering. They can make it so that if one pays 100 times, the malicious code will be installed only 2 times so that they can pass through control networks. The risk of physical extortion of QR codes is yet another problem. 2017 saw a number of accidents in which citizens in China suffered financial damage after scanning a counterfeit QR code on a shared bicycle. Someone had physically changed the real QR code to the counterfeit one.

4.4 The Risk of 'QRLjacking'[12]

1) "QRLjacking," the act of stealing online accounts through QR codes, is yet another risk factor. In 2016, the information security researcher Mohamed Elnubi, from the Mexican security company Seekurity, succeeded in hacking an account in WhatsApp, an instant messenger in the United States that supports QR code login. The hacker initializes the attack target's QR session then proceeds to copy and paste the login QR code into the phishing site created in advance. The phishing site is

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[11] https://www.boannews.com/media/view.asp?idx=81734 , [Security news] Zero Pay and Other Increases in QR Code Users: The Expected Security Issues

[12] ibid.

then sent to the target to induce a QR code scan. When the scan is over, the hacker logs into the target’s account.

5. Violation of the 21st national Assembly member Election (4·15 Type of Election Fraud)

5.1 About the Violation of Constitutional Secret Ballots (Article 31, Paragraph 1 of the Constitution)

The constitutional principle of secret voting is violated, and the infringement of personal information using the QR codes is problematic.

5.2 About the Violation of Article 151, Paragraph 6 of the Public Official Election Act (Using QR Codes)

> Article 151 (Preparation of Ballot Papers and Boxes) Notwithstanding paragraphs (1) and (5), the Gu/Si/Gun election commission shall instruct the official in charge of advance polling management to produce ballot papers to be distributed at advance polling stations with a ballot paper printer at advance polling stations. In such cases, the serial numbers printed on the ballot papers shall be marked in the form of bar code (referring to a code marked in the shape of a bar for recognition by computer), and such bar code may contain the name of election, the name of constituency, and the name of the competent election commission.

As can be found in Articles 11, 38, and 151 of the Public Official Election Act, the early-voting system is stipulated and new barcode regulations[13] have been inserted. The barcode contains the serial number of the ballot, and it is prescribed to be printed not on the return envelope but on the early-voting paper. It contains only the information of the election name, constituency name, and the name of the election committee.

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[13] Public Official Election Act Article 151 (Preparation of Ballot Papers and Boxes)

5.3 Reasons for using the QR Codes Differently from Legal Regulations[14]

The Public Official Election Act only stipulates barcodes and has no mention of "QR codes." Nevertheless, if one thinks about "why the NEC used QR codes," the following reasons can be put together.[15]

(1) The need to include large amounts of information.

(2) The need to plant Chinese characters in QR codes according to the current administration's pro-China policy.

(3) The need for QR code images that apply the steganography technology.

  - As one technology among data concealment technologies, steganography is a technology/research that inserts data into other data.[16]
  - Many security experts warned about the risks of steganography.
  - During the 9.11 terrorist attacks of 2001, steganography was the technology used by Osama bin Laden to exchange messages with the terrorists.
  - Steganography is able to transmit data while hiding the fact that the data is being transmitted, using a method different from data encryption.[17]
  - Steganography allows cyber-spy attackers to remain on infected systems for long periods of time without being suspected.[18]

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[14] https://ieeexplore.ieee.org/document/7509529

[15] <4.15 Problem of Election Fraud>, Lawyer Kwon Woo-hyun 2020.5.23

[16] https://www.dailysecu.com/news/articleView.html?idxno=60528

[17] https://www.dailysecu.com/news/articleView.html?idxno=52638

[18] From Professor Yoo Gi-young from Kyungpook National University Department of Computer Engineering, who wrote a thesis on a subject related to QR codes and steganography

5.4 Georgia Tech's Dr. Richard DeMillo[19]

Dr. Richard DeMillo from Georgia Tech has also expressed serious interest in Korea's election fraud. The following introduces his opinion.

5.4.1 The Problem Of Using QR Codes

① Humans cannot read QR codes.

② When scanning the ballots, we cannot know what information is included.

③ The QR code scanner is vulnerable to hacking.

5.4.2 Dr. Richard DeMillo's Thesis

① Title of Paper: Ballot-Marking Device(BMDs) Cannot Assure the Will of the Voters
② Co-Writers
- Andrew W. Appel / Princeton University
- Philip. B. Stark / Univ. of California. Berkeley

③ Content

ⅰ) The purpose of the thesis is that strict regulations should be placed in regards to the composition of voting machines for electronic voting.

ⅱ) An election conducted by paper ballots is safer than through electronic ballots.

ⅲ) As e-voting machines can be easily hacked, the ballots should be checked for hacking by counting the numbers.

(As long as the ballot box remains securely sealed, checking the numbers by hand is effective.)

ⅳ) Even when voting with paper ballots and not electronically, hacking can occur at any time if the voting classifier and electronic counter are connected to the Internet.

ⅴ) Using foreign-made parts is very dangerous because malware or backdoors hiding within the parts is undetectable.

6. The Discovery of the Same QR Code in Off-Site Early-Voting and Its Resulting Problems

I will now examine and theorize the meaning behind the discovery of the same QR code found in early-voting held outside of the jurisdiction of the Cheongyang County of Buyeo.

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[19] https://youtu.be/f697XrmA_po , [Scott 인간과 자유이야기]

6.1 Summary of Its Occurrence

○ On July 4, 2020, an off-site early-voting ballot paper with the same QR code as another original is found in the waste from the NEC (first aired on Media A).

○ When JoongAng Ilbo reports this on July 21, 2020, the NEC releases an explanation.

- Ballots with same QR codes including serial number and early-voting officer, etc. that have not been marked had been discarded.
- The NEC explained that "As the result of the Cheongyang County Election Commission verifying off-site early-voting ballots in the presence of the Nominations Commission, the existence of the off-site early-voting ballots with the same serial number as reported in the media article has been confirmed."

○ Andong Daily News (On July 23, 2020, reported by reporter Jo Choong-yeol) inquired about the transpiration of these ballots with same QR codes, but both the NEC and the Cheongyang County Election Commission referred to the other and continues to refuse to answer.

6.2 The Explanation Provided by the NEC

"Explanation of the July 22nd Ballot Issuance and Loss" is as follows.

○ The ballots were issued due to the jamming that occurred during the Cheongyang County early-voting, and the original ballots that came out first were torn and stored in a sealed envelope marked for destruction.

○ An employee from the NEC had gone to provide support due to a lack of manpower, and he was to bring this material to the NEC and then to Gyeongju Election Commission (since they were ballots for off-site early-voting) once his work was finished, but the envelope was lost—the process during which, they answered, they judge the envelope to have been treated as waste.

○ On July 21, 2020 (Tue), the NEC released the clarification that, after verifying the off-site pre-election ballot papers in the presence of the Party Nomination Commission, the Cheongyang County Election Commission confirmed that the amount of issued ballots matched the number of votes (1,778), and that from the valid votes, they confirmed the presence of the off-site early-voting ballots with the identical serial number from the media article.

○ Though they apologized for the negligence of management, they have not explained the initial cause for the identical QR codes.

6.3 The NEC's Avoidance of Andong Daily News reporter Cho Choong-yeol's Question (reported July 23, 2020)

Reporter Cho Chung-yeol from Andong Daily asked the following questions around July 21st after recognizing the importance of the case of the same issued QR codes during the reprinting of early-voting ballots, but the fact stands that the NEC acted confused and each avoided answering the reporter.

① What was the situation and who from the NEC participated during the verification of the ballots? ② When confirming the off-site pre-election ballots, who was the one who attended from the Party Nomination Commission? ③ Which member from the NEC was present? ④ In what way were the ballots verified? ⑤ When asked if the '31-digit QR code' for the serial number from the media article matched the unique serial number of the actual ballot, the NEC and Cheongyang County Election Commission both answered by referring the question to the other party, as if they had already decided to answer the such together.

6.4 Existing Claims by the NEC and Revealed Truths

1) Unique QR codes are not assigned to the individual, and the printer generates it in a sequence (False)

-> The truth was that when a specific person's identity is confirmed, a unique QR code is generated for that individual, and if a jamming problem occurs during the printing process, then the given QR code is used as is and is reprinted.

2) The NEC says that the QR codes are not matched to specific individuals (False)

-> The truth was that once a unique QR code is given to a specific individual, a Matching Data is generated for the Entity.

3) When an Entity and its own Matching Code in the form of a QR code is generated, it is

estimated that this information is transmitted and stored at a third, external place (or directly stored by the NEC) using the network at the polling station.

6.5 The Illegality of the Early-Voting Ballot with Identical QR Codes

○ By scanning the QR code and the ballot's image file, it is possible to find which candidate a specific individual voted for. (As an illegal act violating the important principle of secret voting, this disproves the validity of the 21st General Election.)

○ It is presumed that using the identities of the people who had already taken part in the early-voting, duplicate ballots (ghost ballots) were created and put into the ballot box, thus manipulating the number of votes.

○ Since they are using legally eligible voters who completed early-voting, their votes will not overlap at the on-site elections, thereby removing the risk of being discovered at the on-site elections.

7. The need for QR code verification

Below, we will look at the necessity of QR code verification from various angles.

7.1 Simple hand-counting ballots (recounts) are not enough

-Comparison of early-voting records and actual early-voting numbers

-You must check the QR code number in addition to hand-counting the ballots.

(Not only must the constituency QR code and the proportional representative QR code be the same, but the image file of the constituency must have the same QR code, and the contents of the NEC server must be the same)

-You need to check how many types of QR code reader programs exist.

-After receiving the program from the NEC, you need to create a QR code from it.

7.2 The serial number of the QR code should be analyzed

-The QR code contains 4 types of information through 31 digits.

-12 digits are the name of the election, 8 digits are the name of the constituency, 4 digits are the name of the responsible NEC office, and 7 digits are the serial number.

-If a peculiarity is found in the serial number, for example, if there is an empty number or a repetitive number, or if a number greater than the total number of ballots voted is identified, it is evidence of a crime that the ballot has been manipulated.

-If the NEC or the court does not allow QR code analysis, it is like saying they will not analyze the fingerprint from a crime scene.

-It is natural to check the well-preserved computerized system and the ballot's QR code to resolve public suspicion.

-The cost of lawsuit will not reach even 1% of the cost from national suspicion and division.

7.3 Verification of Ballot Sorters and Notebooks

By verifying the ballot sorter, it is possible to check whether a spectrum sensor device that can read the contents of the QR code stamped on the early-voting paper exists. By checking the laptop, it is possible to verify and confirm whether an unofficial program has been installed and whether or not WIFI was used for wireless communication with Huawei repeater.

8. Conclusion

Using a QR code for the early-voting is not only illegal, but the truth must be thoroughly investigated. In addition, there are suspicions of manipulation and intervention by China, such as Huawei of China, surrounding the Hantle system and further investigation regarding this should be made.