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Original Article

The Adoption of Design Thinking in Government Information Systems: An Empirical Study of The Revisions of Notifiable Disease Surveillance System

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Abstract

The Notifiable Disease Surveillance System (NDSS) is one of the important information systems in Taiwan Centers for Disease Control (TCDC), which has been implemented since 1993. In order to provide better service, we need to complete an upgrade and revision of this system. The conventional revision methods often focus on the development of technical levels and lack of concern for business processes, user experience, and service quality.

In this study, we adopted Design Thinking and the Open Policy Making toolkit along with specialists at the Public Digital Innovation Space (PDIS) in order to understand wider aims and needs, recognize underlying drivers and challenges, and generate ideas that correspond with the user needs. We derived 6 principles for system revision: (1) users from medical institution can conveniently complete the notification and specimen submission, (2) public health users can timely obtain data in considering both accuracy and completeness, (3) users may reach the service using mobile devices, (4) a well-developed architecture for the response to business requirements, (5) high system flexibility, and (6) high system availability.

After analysis, we decided that the NDSS platform should be comprehensively re-designed to provide a better user experience and system service.

In this research, we explored the problems and resolutions to update the interface based on user needs. We suggest inviting users to participate in the service design and policy making phase to update the government information systems.

Keywords: Notifiable Disease Surveillance System, design thinking, service design, open policy making

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Weekly Data of Notifiable Infectious Diseases (by week of diagnosis)

Case diagnosis year		Week 24★		Week 1-24			
				2021		2020	
Classification	Disease Diagnosed	2021	2020	Total cases★	Imported cases	Total cases★	Imported cases
Category I	Plague	0	0	0	0	0	0
	Rabies	0	0	0	0	0	0
	SARS	0	0	0	0	0	0
	Smallpox	0	0	0	0	0	0
Category II	Acute Flaccid Paralysis	1	0	14	0	15	0
	Acute Viral Hepatitis type A	1	3	37	0	38	7
	Amoebiasis	6	2	101	34	113	63
	Anthrax	0	0	0	0	0	0
	Chikungunya Fever	0	1	1	1	3	3
	Cholera	0	0	0	0	0	0
	Dengue Fever	0	3	5	5	60	60
	Diphtheria	0	0	0	0	0	0
	Enterohemorrhagic E. coli Infection	0	0	0	0	0	0
	Epidemic Typhus Fever	0	0	0	0	0	0
	Hantavirus Pulmonary Syndrome	0	0	0	0	0	0
	Hemorrhagic Fever with Renal Syndrome	0	1	7	0	7	0
	Malaria	0	0	1	1	1	1
	Measles	0	0	0	0	2	2
	Meningococcal Meningitis	0	0	2	0	5	0
	Paratyphoid Fever	0	0	2	0	0	0
	Poliomyelitis	0	0	0	0	0	0
	Rubella	0	0	0	0	0	0
	Shigellosis	1	1	76	0	79	21
	Typhoid fever	0	0	1	0	5	3
	West Nile Fever	0	0	0	0	0	0
	Zika virus infection	0	0	0	0	2	2
Category III	Acute Viral Hepatitis type B	1	2	67	2	44	2
	Acute Viral Hepatitis type C	10	9	271	0	286	2
	Acute Viral Hepatitis type D	0	0	0	0	0	0
	Acute Viral Hepatitis type E	0	0	5	0	6	0
	Congenital Syphilis	0	0	0	0	0	0
	Congenital Rubella Syndrome	0	0	0	0	0	0
	Enteroviruses Infection with Severe Complications	0	0	1	0	7	0
	Haemophilus Influenza type b Infection	0	0	1	0	3	0
	Japanese Encephalitis	0	0	4	0	0	0
	Legionnaires' Disease	9	11	149	0	119	7
	Mumps	10	6	212	1	216	6
	Neonatal Tetanus	0	0	0	0	0	0
	Pertussis	0	0	0	0	8	0
	Tetanus	0	1	2	0	6	0
Category IV	Botulism	0	0	0	0	0	0
	Brucellosis	0	0	0	0	0	0
	Complicated Varicella	0	0	27	0	23	0
	Endemic Typhus Fever	1	0	16	0	5	0
	Herpesvirus B Infection	0	0	0	0	0	0
	Influenza Case with Severe Complications	0	0	1	0	547	6
	Invasive Pneumococcal Disease	5	1	139	0	145	0
	Leptospirosis	0	0	14	0	19	0
	Listeriosis	3	0	89	0	62	0
	Lyme Disease	0	0	0	0	0	0
	Melioidosis	0	0	8	0	7	1
	Q Fever	0	1	6	0	5	0
	Scrub Typhus	5	6	110	0	116	1
	Toxoplasmosis	0	1	7	0	2	0
	Tularemia	0	0	0	0	0	0
Category V	Ebola Virus Disease	0	0	0	0	0	0
	Lassa Fever	0	0	0	0	0	0
	Marburg Hemorrhagic Fever	0	0	0	0	0	0
	Middle East Respiratory Syndrome Coronavirus Infections	0	0	0	0	0	0
	Novel Influenza A Virus Infections	0	0	1	0	0	0
	Rift Valley Fever	0	0	0	0	0	0
	Severe Pneumonia with Novel Pathogens	1153	0	13088	464	443	388
	Yellow Fever	0	0	0	0	0	0

1. ★The weekly and cumulative total numbers include indigenous and imported cases of notifiable infectious diseases.
2. MDR-TB, Tuberculosis, Syphilis, Gonorrhea, HIV Infection, AIDS, Hansen's Disease and Creutzfeldt-Jakob Disease are excluded from the table.
3. Numbers of mumps and tetanus cases are summed up by the week of report.
4. Since 2020/1/15, "Severe Pneumonia with Novel Pathogens" was listed as a Notifiable Infectious Disease.

Suspected Clusters

●Six clusters related to tuberculosis (4) and diarrhea (2) were reported during week 24.

Imported Infectious Diseases

●There were 12 imported cases from 5 countries during week 24.

Countries / Diseases	Philippines	Indonesia	Peru	India	Japan	Total
Severe Pneumonia with Novel Pathogens	4	2	2	2	1	11
Amoebiasis		1				1
Total	4	3	2	2	1	12

●During week 1-24, there were 496 imported cases from 51 countries. The top three countries are the Philippines (157), Indonesia (113), and India (49).

●During week 1-24, the three notifiable diseases with the highest number of imported cases are Severe Pneumonia with Novel Pathogens (453), Amoebiasis (34), and Dengue Fever (5).

Summary of Epidemic

●**Severe Pneumonia with Novel Pathogens**：The epidemic is slow down gradually. Keeping monitoring impact of the epidemic after the Dragon Boat Festival.

●**Japanese Encephalitis :** Taiwan is in the midst of Japanese Encephalitis season. All counties in Taiwan are at risk of infection.

Weekly Data of Notifiable Infectious Diseases (by week of diagnosis)

Case diagnosis year		Week 25★		Week 1-25			
				2021		2020	
Classification	Disease Diagnosed	2021	2020	Total cases★	Imported cases	Total cases★	Imported cases
Category I	Plague	0	0	0	0	0	0
	Rabies	0	0	0	0	0	0
	SARS	0	0	0	0	0	0
	Smallpox	0	0	0	0	0	0
Category II	Acute Flaccid Paralysis	1	0	15	0	15	0
	Acute Viral Hepatitis type A	0	3	37	0	41	7
	Amoebiasis	0	5	101	34	118	66
	Anthrax	0	0	0	0	0	0
	Chikungunya Fever	0	0	1	1	3	3
	Cholera	0	0	0	0	0	0
	Dengue Fever	0	0	5	5	60	60
	Diphtheria	0	0	0	0	0	0
	Enterohemorrhagic E. coli Infection	0	0	0	0	0	0
	Epidemic Typhus Fever	0	0	0	0	0	0
	Hantavirus Pulmonary Syndrome	0	0	0	0	0	0
	Hemorrhagic Fever with Renal Syndrome	0	1	7	0	8	0
	Malaria	0	0	1	1	1	1
	Measles	0	0	0	0	2	2
	Meningococcal Meningitis	0	0	2	0	5	0
	Paratyphoid Fever	0	0	2	0	0	0
	Poliomyelitis	0	0	0	0	0	0
	Rubella	0	0	0	0	0	0
	Shigellosis	1	1	77	0	80	21
	Typhoid fever	0	0	1	0	5	3
	West Nile Fever	0	0	0	0	0	0
	Zika virus infection	0	0	0	0	2	2
Category III	Acute Viral Hepatitis type B	6	2	73	2	46	2
	Acute Viral Hepatitis type C	11	13	282	0	299	2
	Acute Viral Hepatitis type D	0	0	0	0	0	0
	Acute Viral Hepatitis type E	0	0	5	0	6	0
	Congenital Syphilis	0	0	0	0	0	0
	Congenital Rubella Syndrome	0	0	0	0	0	0
	Enteroviruses Infection with Severe Complications	0	0	1	0	7	0
	Haemophilus Influenza type b Infection	0	0	1	0	3	0
	Japanese Encephalitis	0	3	4	0	3	0
	Legionnaires' Disease	14	5	163	0	124	7
	Mumps	6	15	218	1	231	6
	Neonatal Tetanus	0	0	0	0	0	0
	Pertussis	0	0	0	0	8	0
	Tetanus	0	0	2	0	6	0
Category IV	Botulism	0	0	0	0	0	0
	Brucellosis	0	0	0	0	0	0
	Complicated Varicella	0	7	27	0	30	0
	Endemic Typhus Fever	4	2	20	0	7	0
	Herpesvirus B Infection	0	0	0	0	0	0
	Influenza Case with Severe Complications	0	0	1	0	547	6
	Invasive Pneumococcal Disease	2	6	141	0	151	0
	Leptospirosis	1	0	15	0	19	0
	Listeriosis	2	3	91	0	65	0
	Lyme Disease	0	0	0	0	0	0
	Melioidosis	0	1	8	0	8	1
	Q Fever	1	3	7	0	8	0
	Scrub Typhus	7	19	117	0	135	1
	Toxoplasmosis	0	0	7	0	2	0
	Tularemia	0	0	0	0	0	0
Category V	Ebola Virus Disease	0	0	0	0	0	0
	Lassa Fever	0	0	0	0	0	0
	Marburg Hemorrhagic Fever	0	0	0	0	0	0
	Middle East Respiratory Syndrome Coronavirus Infections	0	0	0	0	0	0
	Novel Influenza A Virus Infections	0	0	1	0	0	0
	Rift Valley Fever	0	0	0	0	0	0
	Severe Pneumonia with Novel Pathogens	651	3	13737	470	446	391
	Yellow Fever	0	0	0	0	0	0

1. ★The weekly and cumulative total numbers include indigenous and imported cases of notifiable infectious diseases.
2. MDR-TB, Tuberculosis, Syphilis, Gonorrhea, HIV Infection, AIDS, Hansen's Disease and Creutzfeldt-Jakob Disease are excluded from the table.
3. Numbers of mumps and tetanus cases are summed up by the week of report.
4. Since 2020/1/15, "Severe Pneumonia with Novel Pathogens" was listed as a Notifiable Infectious Disease.

Suspected Clusters

●Nine clusters related to tuberculosis (7), diarrhea (1), upper respiratory tract infection (1) were reported during week 25.

Imported Infectious Diseases

●There were 4 imported cases from 4 countries during week 25.

Diseases \ Countries	Austria	Philippines	Brazil	Japan	Total
Severe Pneumonia with Novel Pathogens	1	1	1	1	4
Total	1	1	1	1	4

●During week 1-25, there were 500 imported cases from 52 countries. The top three countries are the Philippines (158), Indonesia (113), and India (49).

●During week 1-25, the three notifiable diseases with the highest number of imported cases are Severe Pneumonia with Novel Pathogens (457), Amoebiasis (34), and Dengue Fever (5).

Summary of Epidemic

●**Severe Pneumonia with Novel Pathogens**：The epidemic is slow down gradually. The number of newly confirmed cases expected to be less than 100 and may detect COVID-19 cases likely due to infections cases by the Delta variant.

●**Japanese Encephalitis :** Taiwan is in the midst of Japanese Encephalitis

Weekly Data of Notifiable Infectious Diseases (by week of diagnosis)

Case diagnosis year		Week 26★		Week 1-26			
				2021		2020	
Classification	Disease Diagnosed	2021	2020	Total cases★	Imported cases	Total cases★	Imported cases
Category I	Plague	0	0	0	0	0	0
	Rabies	0	0	0	0	0	0
	SARS	0	0	0	0	0	0
	Smallpox	0	0	0	0	0	0
Category II	Acute Flaccid Paralysis	0	0	15	0	15	0
	Acute Viral Hepatitis type A	0	1	37	0	42	7
	Amoebiasis	1	4	102	34	122	70
	Anthrax	0	0	0	0	0	0
	Chikungunya Fever	0	0	1	1	3	3
	Cholera	0	0	0	0	0	0
	Dengue Fever	0	0	5	5	60	60
	Diphtheria	0	0	0	0	0	0
	Enterohemorrhagic E. coli Infection	0	0	0	0	0	0
	Epidemic Typhus Fever	0	0	0	0	0	0
	Hantavirus Pulmonary Syndrome	0	0	0	0	0	0
	Hemorrhagic Fever with Renal Syndrome	0	0	7	0	8	0
	Malaria	0	0	1	1	1	1
	Measles	0	0	0	0	2	2
	Meningococcal Meningitis	0	0	2	0	5	0
	Paratyphoid Fever	0	0	2	0	0	0
	Poliomyelitis	0	0	0	0	0	0
	Rubella	0	0	0	0	0	0
	Shigellosis	0	2	77	0	82	21
	Typhoid fever	0	0	1	0	5	3
	West Nile Fever	0	0	0	0	0	0
	Zika virus infection	0	0	0	0	2	2
Category III	Acute Viral Hepatitis type B	5	0	78	2	46	2
	Acute Viral Hepatitis type C	13	14	295	0	313	2
	Acute Viral Hepatitis type D	0	0	0	0	0	0
	Acute Viral Hepatitis type E	0	0	5	0	6	0
	Congenital Syphilis	0	0	0	0	0	0
	Congenital Rubella Syndrome	0	0	0	0	0	0
	Enteroviruses Infection with Severe Complications	0	0	1	0	7	0
	Haemophilus Influenza type b Infection	0	0	1	0	3	0
	Japanese Encephalitis	3	1	7	0	4	0
	Legionnaires' Disease	5	3	168	0	127	8
	Mumps	7	12	225	1	243	6
	Neonatal Tetanus	0	0	0	0	0	0
	Pertussis	0	0	0	0	8	0
	Tetanus	0	0	2	0	6	0
Category IV	Botulism	0	0	0	0	0	0
	Brucellosis	0	0	0	0	0	0
	Complicated Varicella	2	0	29	0	30	0
	Endemic Typhus Fever	1	1	21	0	8	0
	Herpesvirus B Infection	0	0	0	0	0	0
	Influenza Case with Severe Complications	0	0	1	0	547	6
	Invasive Pneumococcal Disease	2	1	143	0	152	0
	Leptospirosis	2	2	17	0	21	0
	Listeriosis	5	5	96	0	70	0
	Lyme Disease	0	0	0	0	0	0
	Melioidosis	0	0	8	0	8	1
	Q Fever	0	0	7	0	8	0
	Scrub Typhus	7	8	124	0	143	1
	Toxoplasmosis	0	0	7	0	2	0
	Tularemia	0	0	0	0	0	0
Category V	Ebola Virus Disease	0	0	0	0	0	0
	Lassa Fever	0	0	0	0	0	0
	Marburg Hemorrhagic Fever	0	0	0	0	0	0
	Middle East Respiratory Syndrome Coronavirus Infections	0	0	0	0	0	0
	Novel Influenza A Virus Infections	0	0	1	0	0	0
	Rift Valley Fever	0	0	0	0	0	0
	Severe Pneumonia with Novel Pathogens	446	1	14183	481	447	392
	Yellow Fever	0	0	0	0	0	0

5. ★The weekly and cumulative total numbers include indigenous and imported cases of notifiable infectious diseases.
6. MDR-TB, Tuberculosis, Syphilis, Gonorrhea, HIV Infection, AIDS, Hansen's Disease and Creutzfeldt-Jakob Disease are excluded from the table.
7. Numbers of mumps and tetanus cases are summed up by the week of report.
8. Since 2020/1/15, "Severe Pneumonia with Novel Pathogens" was listed as a Notifiable Infectious Disease.

Suspected Clusters

●Ten clusters related to tuberculosis (5) and diarrhea (5) were reported during week 26.

Imported Infectious Diseases

●There were 17 imported cases from 9 countries during week 26.

Diseases \ Countries	Indonesia	USA	Cambodia	UK	Philippines	Hungary	India	Japan	Saudi Arabia	Total
Severe Pneumonia with Novel Pathogens	4	3	2	2	2	1	1	1	1	17
Total	4	3	2	2	2	1	1	1	1	17

●During week 1-26, there were 516 imported cases from 53 countries. The top three countries are the Philippines (160), Indonesia (117), and India (50).

●During week 1-26, the three notifiable diseases with the highest number of imported cases are Severe Pneumonia with Novel Pathogens (473), Amoebiasis (34), and Dengue Fever (5).

Summary of Epidemic

●**Severe Pneumonia with Novel Pathogens**：The epidemic is slow down gradually. The number of newly confirmed cases expected to be less than 100 per day and new cases with Delta variant should be aware.

●**Japanese Encephalitis :** Taiwan is in the midst of Japanese Encephalitis season. All counties in Taiwan are at risk of infection.

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