# Business process analysis of a foodborne outbreak investigation mobile system

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**Abstract.** Epidemiological investigation during an outbreak of food-borne disease requires taking a number of activities carried out in the field. This results in a restriction of access to current data about the epidemic and reducing the possibility of transferring information from the field to headquarters. This problem can be solved by using an appropriate system of mobile devices. The purpose of this paper is to present the IT solution based on the central repository for epidemiological investigations and mobile devices designed for use in the field. Based on such a solution business processes can be properly rebuild in a way to achieve better results in the activities of health inspectors.

## 1. Introduction

Foodborne outbreak investigations require a number of responses performed in different areas. This results in a restriction of access to current data about the epidemic and a reduction in the possibility of transferring information from the field to headquarters. The problem can be solved by using an appropriate system equipped with mobile devices. The use of mobile devices in the field allows instant access to current data of the epidemic. It also allows the transmission of up to date information on patients' examination results and food preparation facilities audits.

Business process modelling techniques were employed to improve sanitary inspectors' activities in the field. Business Process Model and Notation (BPMN) were used to describe these improved processes. It can be shown that teams equipped with mobile devices can execute their tasks more efficiently.

## 2. Business process models in the mobile variant

Thanks to the development mobile technology in recent years it became possible to transfer data from on-site inspections and data from interviews with patients immediately after they have been obtained to authorities responsible for the coordination of an outbreak investigation. This approach significantly shorten the time needed to detect sources of the illness and the ways the disease spreads. It contributes to faster prevention of epidemics and a significant reduction in the number of sick and dead.

Therefore, the existing business processes are redesigned in such a way as to fully exploit the opportunities provided by an instant access to information from the field [1].

Figure 1 presents selected business process (the epidemiological inquiry) in a variant using mobile devices. The process allows you to perform a series of steps that lead to finding the causes and sources

of an outbreak. Therefore, interviews with patients are conducted as well as health inspections at food distribution points.

The activities carried out are documented and registered in the system. On the basis of that information the epidemiology department can analyse the results and make appropriate decisions regarding the epidemic. All cases are placed on the map, it helps in qualifying them for the same or a new outbreak of the disease.
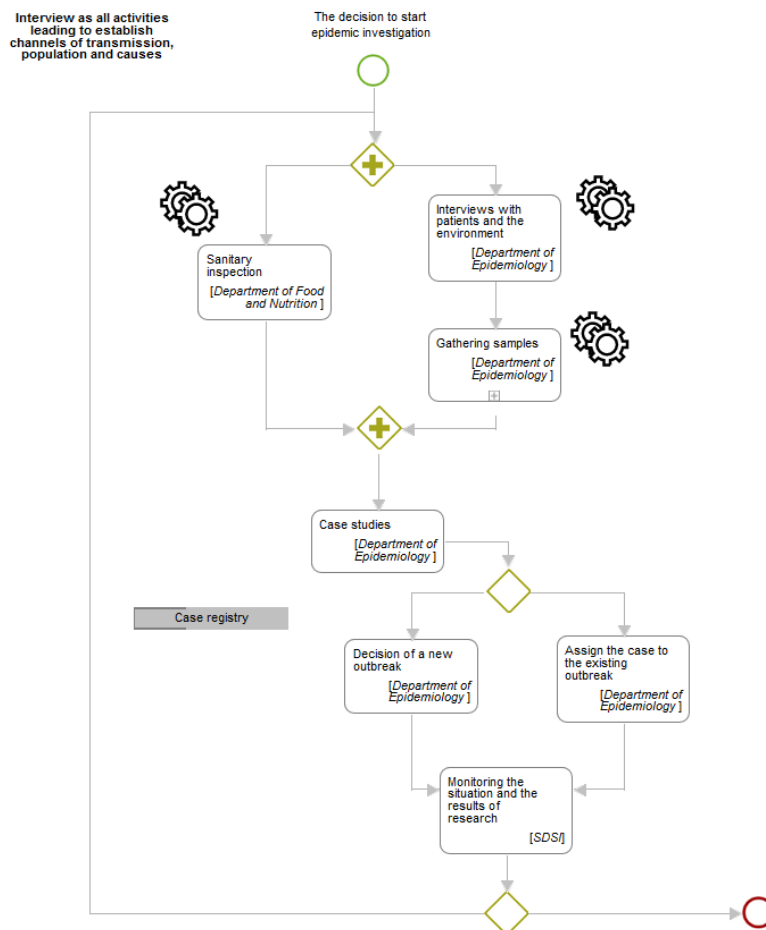


**Figure 1.** Epidemiological inquiry process diagram. Source: own elaboration.

Steps in the process [6, 7], which can be supported through the use of mobile devices or the software are shown in the diagrams market with the 'gears' icon. Usage of mobile devices is represented by labels and descriptions on the diagram.

## 3. Mobile devices in the work of the health inspection

The coordinating inspector contracts all the tasks performed by field inspectors. Inspectors, working in the field, perform the tasks ordered to them. Then they introduce the results directly to the System [2, 5]. The use of mobile devices, in this case allows to enter data directly which significantly speeds up the task processing time, and accelerates the implementation of the necessary analysis needed to make a decision by the coordinating inspectors. Mobile devices also provide remote and immediate access to information on the investigation contained in the central system (figure 2).
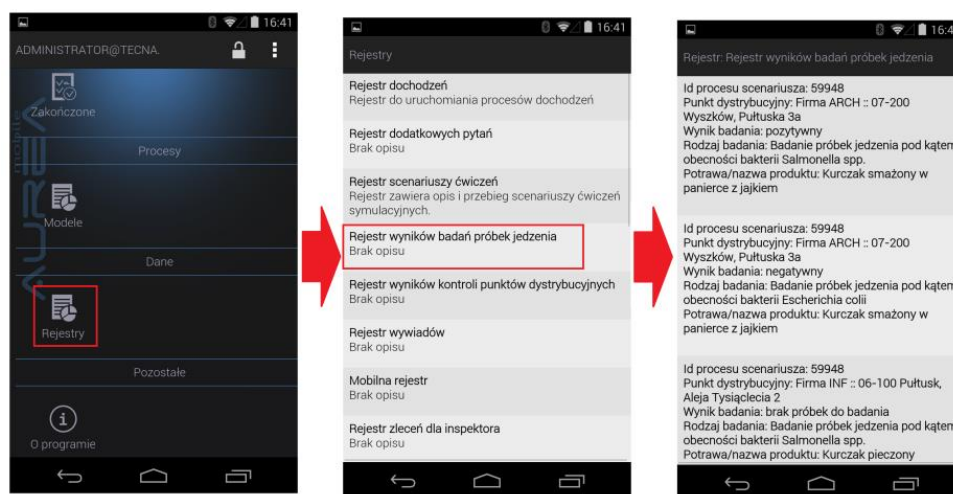
**Figure 2.** Ability to view records epidemiological investigations while working in the field. Source: own elaboration.

The mobile solution also allows the use of maps and routing to the next controlled object. Inspectors have also a fast access to full documentation of the epidemiological investigation. This documentation may be updated at the mobile device using the forms filled out during the inspection, also with the ability to attach photos and recordings (figure 3).
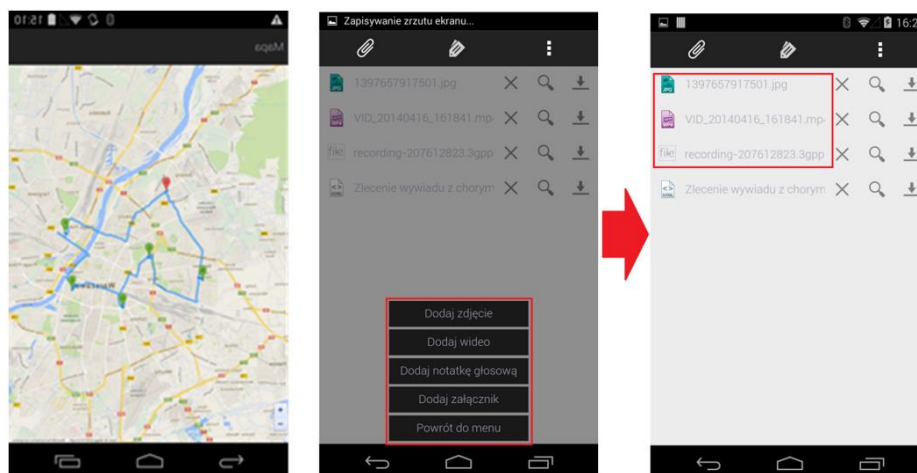


**Figure 3.** Mobile device features used during epidemiological investigations. Source: own elaboration.

## 4. Process performance comparison

In order to make the comparison of process performance between the classic variant and a mobile variant two separate investigations were conducted:

1  The outbreak investigation in the epidemic of a food-borne disease during which all sanitary inspectors use the system on desktop or laptop computers, which are located in the county sanitary-epidemiological stations.

2  The outbreak investigation in the epidemic of a food-borne disease during which all sanitary inspectors use the system on desktop or laptop computers, which are located in the county sanitary-epidemiological stations but, in contrast, sanitary inspectors working in the field use mobile devices such as smartphones and tablets.

For both investigations the simulation of the epidemic was carried out, based on the scenario, which defined, among others, the source of infection, the etiological factor causing poisoning and the amount of contaminated food. The exercise scenario for both investigations was the same, which means that both investigations were carried out for the same conditions and parameters of the simulation.

To evaluate the efficiency of processes, the following criteria and indicators were considered:

1    The duration of an outbreak investigation,
2    The number of reported cases and deaths connected with the outbreak.

The use of mobile devices effects on the duration of the whole investigation. By improving the work of field inspectors and instant communication with the headquarter, it was possible to make faster decisions by coordinating inspectors. The results of the field inspectors' work (e.g. the results of patient interviews and health checks) were inputted immediately into the system and immediately analyzed by the coordinating inspector. This resulted in the quicker decision making, what had a significant impact on the time of contamination detecting and appropriate anti-epidemic action taking.

There were two simulation exercises started at the same time – June the 1st. In the case of the classical approach, the outbreak was closed on June 16, but using mobile devices outbreak was closed 2 days earlier - on the 14th of June.

It may be noted that the use of mobile devices shortened the time needed to close the outbreak, what resulted lower number cases and deaths.

Mobile devices allow access to current investigation data directly from the field. Immediate transfer of the results of the field inspectors' work to the coordinating inspectors allows them to make quick decisions and conduct more efficient investigation. The earlier break of the transmission routes of contaminated food reduces the total number of cases. It can be seen that for the second exercise, which uses mobile devices, the total number of cases decreased [3, 4]. Furthermore, ill patients began to recover earlier. The percentage of recovered patients is higher than in the case of exercise, wherein the mobile device were not used (figure 4 and figure 5).
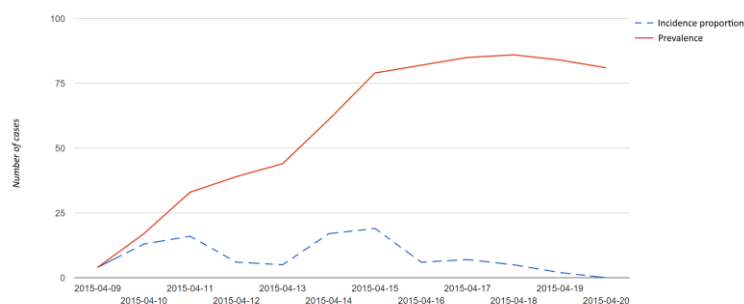


**Figure 4.** Epidemic curve for exercises carried out in accordance with a classical approach. Source: own elaboration.
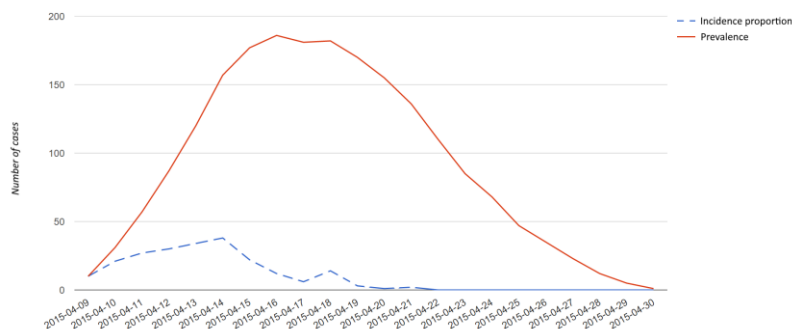


**Figure 5.** Epidemic curves for exercises performed on mobile devices. Source: own elaboration.

**5. Conclusions**

Sanitary inspection activities can be modeled as business processes. It has been shown that regardless of traditional, centralized business in the epidemiological investigations, the modern, innovative approach be used introducing mobile devices and involving the possibility of a rapid exchange of data between inspectors operating in the field and the sanitary-epidemiological station.

As the result, the BPMN process models were designed in a way that assumes that tasks can be performed remotely. The results of the designed solution have been evaluated for their effectiveness in shortening the duration of the epidemiological investigation. The effectiveness of sanitary inspectors was compared in two variants of business processes: the first that assumes using of mobile devices and the second - classical – that assumes access to the system only from the headquarter. Two groups of investigators conducted separate outbreak investigations. In the first group, all sanitary inspectors used the system on desktops or laptops that were available only in the county sanitary-epidemiological offices. In the second group sanitary inspectors that were coordinating actions used the system on desktop computers, which were located in the county sanitary epidemiological stations, and sanitary inspectors working in the field used mobile devices such as smartphones and tablets. For both investigations an outbreak simulation was carried out based on the scenario, which defined, among others, the source of infection, the etiological factor causing poisoning and the amount of contaminated food. The exercise scenario for both investigations was the same, which means that both investigations were carried out based on same conditions and parameters of the simulation. To evaluate the efficiency of processes [5] the duration of an outbreak investigation as well as the number of reported cases and deaths associated with the outbreak were considered.

As the conclusion, it has been shown that the use of mobile devices significantly shortens the duration of foodborne outbreak investigations. This is very important factor from the point of view of reducing the consumption of contaminated food and consequently the number of people affected by an outbreak.

**References**
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