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Creating the Population's Situational Awareness of the State/Status and Threats of Covid-19 By Using Modern Information Technology

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Abstract:

The paper attempts to systematically present the problem of creating the desired level of situational awareness of the population by indicating the possibility of a comprehensive approach to the threats, evaluation of the risk associated with the materialisation of these threats and its impact on the state of situational awareness.

Based on this analysis, it was proposed to model the possibilities of counteracting the effects of risk through the use of modern information technologies, including the integration of the information database on threats, with particular emphasis on the Things Internet platform and Big-Data class systems.

Against this background, the role of multi-faceted exploration of data on threats, the intensity and directions of their spread has been highlighted. This applies in particular to the promotion of the level of situational awareness not only of the society but also of local-level, state-level and international-level authorities and organisations managing the crisis under COVID-19 conditions.

However any threats and disruptions to information systems directed to the population can cause confusion and chaos, which can naturally result in a real risk of reduced ability by various entities and the whole society, or by selected communities, to perform their tasks.

Keywords: *Situational awareness, threat, risk, security, system, IT tools, evaluation*

Paper Type: *Research in Security Studies.*

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1. Introduction

Situational awareness (SA[2]. Endsley M.R., 2015, pp. 101-111) is a systemic category related to the need for effective management of modern organisations, often operating not only in territorial dispersion but also in task-functional dispersion. Access to uniform, fairly homogeneous and up-to-date information is an important factor for effective and continuous action. Up-to-date information and informational business continuity are in fact a factor conditioning the processes of creating situational awareness of various interested parties of a given system of activity.

The process to create situational awareness forces the need for access to a common assessment of the current situation in time and space for specific operating conditions. An access to selected data on threats, as well as on in-house resources and on the possibilities of the environment's operations is an essential condition for ensuring business continuity (Zaskórski, Woźniak *et al.*, 2020).

Situational awareness can therefore promote effectiveness and decision efficiency at every level of decision making. The creation of situational awareness in crisis situations is a particularly important process, which is time- and spatially determined. Each participant and recipient of the consequences of the threats and events identified should receive a communicative message, at an appropriate level, without time or place limitations. Decision-makers must also have data at their disposal to enable dynamic evaluation of the state of resources and the possibilities for actions after a change in the situation. A common understanding of the environment and key parameters determining the change in the state of a specific subject of action is essential for all participants in a specific process, especially in the response phase in the full cycle of crisis management (Borodzicz, 2005; Crandall, Parnell, and Spillan 2014).

2. Determinants of Situational Awareness

The process of creating situational awareness is integrated into the process of analyses and objective assessment of the condition of the environment of a given entity and into the process of forecasting external events in the context of one's own actions and implementation of the established operational and strategic goals. Managers of systems for ensuring the security of citizens should strive for a developed situational awareness of the population, which can synergistically strengthen the potential of these systems and the effectiveness of a threats prevention.

Strengthening the potential of a given organisation may also be associated with uniform interpretation of situations and events and people's behaviour (intuition),

[2] *Situation Awareness.*

which determines the proper selection of data about situations, and, prior to that, the scope of monitoring and control. Lack of situational awareness or its inappropriate level can be considered as a determinant of wrong human behaviour (contractors of a given process).

Therefore, situational awareness requires proper control of information flow processes under conditions of increased intensity of events, and incorrect decisions may increase the level of risk and undesirable effects of its materialisation.

The assessment of situational awareness is oriented primarily on the plane not only of its states, but also of procedures (systems) and the processes of its formation (Figure 1). Processes are a dynamic component of every system of operations and due to the procedures adopted in the system they lead to a dynamic, purposeful change in the level of situational awareness in subsequent time intervals. In modern systems of operations functioning in a virtual environment, the state of actual situational awareness of each interested party is important. Situational awareness systems should therefore ensure that this awareness is shared and distributed among contractors and crisis managers and among the various interested parties in the environment. The creation of the desired state of situational awareness is related to the sequential process of perception of elements of the environment, understanding the situation and predicting the future state (the whole system of operations and related environmental objects).

The category of situational awareness is naturally linked to difficult or complex situations both structurally and procedurally. Achieving a good level of situational awareness is usually the result of constant observation of conditions (environment) and results of current activities and anticipation of subsequent events (e.g. simulations). Such awareness is therefore a consequence of combining the phases of "observation" and "orientation" in the so-called Boyd cycle[3] (observation-orientation-decision-action) with the phase of determining future states e.g. the threat state (forecasting). Situational awareness is nowadays becoming an important component of actions in special situations, such as the crisis situation caused by the COVID-19 virus today.

SYSTEM KREOWANIA ŚWIADOMOŚCI SYTUACYJNEJ LUDNOŚCI	SYSTEM FOR CREATING SITUATIONAL AWARENESS OF THE POPULATION
Procesy kształtowania świadomości sytuacyjnej:	Processes to shape situation awareness:
obserwacja – percepcja – planowanie działań (zachowania)	observation - perception - the planning of actions (behaviour)
Identyfikacja zagrożeń COVID-19	Identification of COVID-19 hazards

[3] *https://www.artofmanliness.com/articles/how-to-develop-the-situational-awareness-of-jason-bourne (accessed on October 27, 2019)*

Ewaluacja ryzyka utraty bezpieczeństwa zdrowotnego	Evaluation of a risk to lose health security
Opracowanie wyników i informowanie ludności	Developing results and informing the population
Ocena stanu świadomości sytuacyjnej	Assessment of a state/status of situational awareness
System zarządzania kryzysowego COVID-19	Crisis management system COVID-19

Figure 1. *General model for creating situational awareness*

Source: *In-house elaboration compiled on the basis of: Endsley M.R., 2000.*

Achieving adequate awareness of the threats and the possibilities to counteract them is a prerequisite for the effective functioning of individuals and entire entities in a highly volatile and unpredictable environment. The way in which threats, their intensity and protection methods and measures are presented, can be strongly determined by the new information technology platform. The use of cloud computing services and the availability of information resources without space and time limitations may be conducive to fulfilling the condition of integrating activities in a distributed model (Zaskórski, Woźniak *et al.,* 2020). This may mean strengthening the forces and measures in the crisis management system at various levels of threats.

The situational awareness is therefore a concept of shaping needs and proper information flows about the changing picture of the effects of a given threat in a given area. The information resources collected and distributed in cyberspace on the status of threats and foreseeable consequences can meet the need to assess the situation directly and to obtain situational awareness in direct communication with individual and collective recipients of such information. Whole communities and societies thus become a "learning" organisation.

Access to the above-mentioned information resources, organised by domain, as well as spatially and temporally, leads to the promotion of behavioural patterns through the analysis of phenomena and their prediction with the use of analytical and decision-making systems (including data warehouse technology, Zaskórski, 2012, pp. 245-280) and Big-Data systems (Mayer-Schonenberger and Sugar, 2014), with the increasing use of systems monitoring e.g. population health conditions with the use of the IoT/Internet-of-Things platform (Cucumber and Zaskórski, 2018) and IoE/Internet-of-Everything. The use of this class of technologist may strengthen the achievement of the appropriate level of SA and ultimately foster the so-called understanding of the situation according to e.g. the Endsley model, which de facto is an understanding of each phenomenon and the ongoing perception of the importance of information links in order to achieve the recommended level of knowledge (Endsley, 2000[4]) in the context of how to interpret the information obtained accurately.

Appropriate mental models[5] can strongly condition situational awareness according to the information resources and knowledge databases (e.g. use of "data-mining" mechanisms in OLAP/DM or Big-Data systems) generated in the long run according to observed events and experiences. An important component of the process of creating the desired situational awareness level are also the mechanisms of information selection and rugging of information and data distorting this awareness. It is therefore necessary a procedure to select the most appropriate option (behaviour) on the basis of conceptual schemes (knowledge base) which become a representation of mental models (Seeafty *et al.,* 1997).

Such coherent action can ensure the complementarity of information and decision-making processes in emergency and crisis situations. This requires the accurate indication of mental models and the selection of an informational scope tailored to a given group of interested parties and describing a specific situation on an ongoing basis, with the possibility of its distribution in cyberspace in accordance with the rules of informational business continuity (Zaskórski, Woźniak *et al.,* 2020) without time and spatial-geographical limitations.

3. Sources and Risk Factors and their Heterogeneity and Ambiguity under COVID-19 Conditions

The quantification of the situation awareness level of the population under COVID-19 conditions implies the need for a continuous process of identifying sources and risk factors that may reduce this level. One important risk factor for reducing

[4] *"it is important to distinguish the situational awareness term as a state of knowledge from the processes used to achieve this state. These processes can vary considerably from person to person and from context to context and can be referred to as situation assessment or processes to achieve, obtain or maintain situational awareness."*

[5] *http://sateclmologies.com/publications (accessed on October 27, 2019).*

situational awareness is the poor definition of the disease itself and its attributes, which may result from excessive specialisation in the medical world. Many messages indicate that it is difficult to diagnose this disease unequivocally on the basis of symptoms if the set of these symptoms is fuzzy. This means that the process of prophylaxis and the process of extended diagnostics may be subject to considerable risk in itself. Therefore, there is a need to make available synthetic knowledge about the coronavirus phenomenon, not only in medicine, but also in other fields such as sociology, economics, psychology and even political science, which is particularly relevant when determining the effects of COVID-19 threats on their global dimension. The number of specialists with such extensive knowledge is not very large.

An important factor in reducing situational awareness is also the feeling of uncertainty in forecasting the effects of threats both locally and globally. Moreover, the expectations of formal (governmental) structures are a kind of increase of a level of this uncertainty. The result may be an erroneous or even hypocritical picture of a COVID-19 type pandemic, which translates into the generation of erroneous recommendations and actions that also make the desired situational awareness level fuzzy. A certain example of this can be seen in the deliberations on the pandemic (Jabłoński[6], 1980), where at that time "Coronavirus" was already identified as: "small respiratory diseases - upper respiratory tract infections and bronchitis" and further on, "Viruses occur in adults ..... are transmitted through the drip- airway ..... The same rules apply as for other viral respiratory diseases".

This means that the coronavirus (SARS-CoV-2) causing COVID-19 may not be a new virus. In addition, it is assessed, in comparison with other viruses, as a fairly mild threat, which is less dangerous for young people. Fatalities are mainly occurred among the weak and ill, elderly people. Moreover, the media coverage is not reliable enough in this regard, since generally only the number of the diseases and the number of victims are given, and quite rarely their age and the type of other diseases from which they have suffered.

There is a lack of information on the method of treatment and diagnosis and on the duration of treatment. It seems that for a comprehensive picture of the assessment of causes and effects of the risk of loss of health security, there may be information about the period that has elapsed since the occurrence of representative symptoms and the beginning of the process of diagnosis and subsequent treatment (observation-understanding-diagnosis and decisions, as in the OODA cycle). The correlation [7] between the patient's age, his/her living conditions versus the diagnosis and effect of COVID-19 is confirmed, because: "More than 30% of those who died in Los Angeles on COVID-19 were in nursing homes, and in Long

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[6] *https://dorzeczy.pl/opinie/137860/uczona-niewiedza-koronawirusa-wielka-pandemia-czy-najwieksza-pomylka.html (accessed on July 31, 2020)*

[7] *The San Diego Union Tribune of April 19, 2020*

Beach, the elderly from nursing homes accounted for 70%."

The majority of the deaths in the USA belonged to the group at risk as elderly people with previous health problems. According to current data from Spain, the average age of deceased people is 82 years old, with a strong correlation with coexisting diseases (95% of deceased people). The analysis of these risk factors therefore makes quite important recommendations as to the extent and level of situational awareness, which can be underestimated by the psychosis of coronavirus fear, and this can have quite significant economic and social consequences. Thanks to such incomplete information, even young people reduce their professional/employment activities. Domestic isolation and other restrictions, including the closure of schools and other institutions and the locking of borders, are effects that lower the standard of social and economic life as a result.

Many specialists say in the media that the coronavirus is probably more expansive and causes more mortality among the elderly but should not be considered much more dangerous than influenza. In addition, the comparative statistics show that it is also less dangerous - from the point of view of fatalities - than many other diseases, threats, and social phenomena. Reducing the effects of the COVID-19 threats indicates the need to isolate only elderly and seriously ill people. A good reference can be made to various ongoing analyses and evaluations [8] (e.g. www.Worldometer [10]): "over 851,000 people in the world died this year from coronavirus, about 500,000 from influenza, about 600,000 from malaria, about 1 million from HIV/AIDS, over 4 million people from cancer and about 4 million people from other infectious diseases ..... In addition, there were almost 500,000 suicides, almost 1 million from road accidents, over 2.3 million people from child deaths (mainly from hunger) during the same period".

The process of creating an appropriate level of situational awareness should take into account the fact that the use of radical emergency measures, covering the whole of society, does not seem to be appropriate, especially in view of the promotion of the effects of such measures on many areas of socio-economic life. Complete information can objectivise a comprehensive assessment of the COVID-19 threat phenomenon and a more accurate political and economic decision-making process. Important consequences of the misshaping of situational awareness and the very picture of the risks associated with COVID-19 include a lack of income and the collapse of companies (including numerous suicides). A crisis situation caused by this virus may also result in the collapse or narrowing business operations of many entities (including business companies) and the loss of jobs.

Many people who are active in the labour market will fall into a state of depression

[8] *www.who.int - WHO (accessed on August 17, 2020).*
[9] *https://www.worldometers.info/coronavirus (accessed on August 31, 2020).*
[10] *https://www.worldometers.info/coronavirus (accessed on August 31, 2020).*

when they are locked up in their homes. It should also be noted that especially in the elderly, the body's immune system may deteriorate (e.g. lack of exercise). Fear and trauma as a result of coronavirus psychosis can also be significant, and these effects can be lasting in the memory of man, community, and society. Once again, it is possible to refer here to the process and state of situational awareness of the population, when children, in fear of the coronavirus, do not take normal medical advice and there are extreme threats to their lives. A large proportion of deaths (e.g. from heart attacks, diabetes) may be due to low situational awareness levels and the use of overly radical bans and injunctions.

The sources of risk associated with COVID-19 can still be looked at through the prism of business rules. The crisis situation resulting from this threat becomes an opportunity to make a profit. Some forecasts indicate that the financial resources allocated to health care on a global scale currently exceed almost three times the expenditure on armaments. Every epidemic is a challenge for the industrial and service sector, including research and then the production and distribution of vaccines. This requires a thorough research process and an equally thorough society awareness process in this area.

Moreover, there is an awareness of the necessary limitations, until the time needed to invent and confirm the effectiveness of these specifics (several months or maybe years). Therefore, taking into account the sources and factors of the pandemic spread risks and factors of the escalation of its various effects, it is necessary, above all, to limit the circle of people who are not subject to such strict rigour and anti-crisis recommendations. If the efficacy of such vaccines has been confirmed, only vulnerable people, including the elderly with respiratory and other illnesses, as well as healthcare workers and government officers who are constantly exposed to potentially infected people, may be vaccinated.

Another threat arising from the limited effectiveness of the vaccine itself becomes important (viruses have a specific ability to mutate rapidly and a given type of vaccine may not be effective at a certain place and time). This is also an important aspect in the process of shaping the situational awareness. It is worth emphasising here the possibility of additional complications due to a poorly tested vaccine and the additional danger of even the initiation of the disease resulting from the use of the vaccine itself, and even the risk of a so-called post-vaccination epidemic. All of this should be an integral part of the fight against the coronavirus, considering the pursuit of profit by pharmaceutical companies, which in itself is a risk factor for the health security disturbance of the population.

The situational awareness level should cause the society to conclude that the true defence against the coronavirus is individual immunity, which, in addition to the hygienic recommendations (staying at home and social isolation), is essential to strengthen it. Therefore, measures are required to counteract the reduction of immunity (e.g. physical activity / exercises). As mentioned earlier, this immunity is

also worsened by fear and stress. Wearing masks and restricting access to fresh air is also not conducive to strengthening immunity. The process of shaping the situational awareness should therefore indicate the need to inform that such safeguards are only valid for close contact in congested public places, and particularly in enclosed spaces[11].

The observation and analysis of threats and the materialisation of the effects of the risks associated with COVID-19 so far indicates that the number of patients will continue to increase until some point, and this aspect should be highlighted in the process of creating an adequate situational awareness level. This requires adequate preparation and, above all, adequate information resources on the sources, factors, and effects of this class of threats. These resources should confirm the scale of the threat, but also compare the real effects of these threats and reference to the effects caused by other viruses.

In order to make rational use of data and information, therefore, it is not necessary to select them for ad hoc purposes. The use of radical methods that are currently being used in many countries (locking people up in their homes and having fines for leaving) may prove ineffective. This information should also be reflected in the information resources of decision-makers at various levels, particularly in terms of the results obtained (reduction in the number of illnesses, deaths, etc.).

A more important component of these measures seems to be prevention and information about preventive measures and appeals to human reason based on the knowledge available to the society. There is no doubt that the coronavirus has become a media event, and so an information centre on the worldwide spread of COVID-19 has been set up at Johns Hopkins University in Baltimore, USA.

There are important current data on the number of patients, the number of healers and the number of deaths both globally and in relation to individual countries. It is worth noting that this is also a kind of business associated with this virus. The data collected and published are conducive to the escalation of financial needs for the fight against the coronavirus. The phenomenon of the scale of needs for this fight can be registered, with the economic recession already observed (the number of unemployed in the USA alone is increasing and approaching 20%).

Similar phenomena may occur in many other countries. The risk (ISO 31000:2018) associated with COVID-19 threats is a multidimensional phenomenon. In socio-economic terms, various restrictions (closing borders, suspension of travel, home isolation, etc.) weaken the global economy. Insufficient attention to current and proper situational awareness creates a situation where some entities gain, and others unfortunately lose because of such insufficient attention. This does not

[11] *https://dorzeczy.pl/opinie/137860/uczona-niewiedza-koronawirusa-wielka-pandemia-czy-najwieksza-pomylka.html (accessed on July 31, 2020)*

always provide a reliable picture of the scale of the threats, risks, and opportunities for reducing the effects of the materialisation of these threats.

4. Assessment of Risk to Lose Health Security - Models and Processes

The evaluation of the risk of loss of health security associated with the COVID-19 pandemic must consider the reliability and continuity of the system for informing the population about the threats arising from the spread of this virus. The risk of the COVID-19 virus infection is a real reflection of the effectiveness of the authority taking certain actions, which should be based on a reliable and full flow of information about the threats and possible consequences and on trust and interaction with citizens.

This is because it concerns a crisis situation with quite considerable dynamics of change and an unspecified deadline for its end. Citizens should not be hindered in their basic activities guaranteeing their development and socio-economic security. It can be assumed that society will survive isolation for some time. This applies above all to the oldest people most at risk, who, as a result of their various experiences and thanks to their self-discipline and patience, will adhere to the established restrictions. Counteracting the risk of loss of health security will also require support from local communities (e.g. assistance in shopping). For the younger generation, this assumption is unlikely. Younger people will circumvent various types of rigour, which may increase the risk of increasing the incidence of disease among other social groups[12].

In order to effectively counteract threats and be aware of their gradation, the causes and effects of risks (Xing, Zeng, and Zio, 2019), placed in various areas of the socio-economic life of a country, need to be carefully analysed. Evaluation of the level of risk to lose the health security requires the identification of risk factors and the associated level of security as a logical complement to the estimated risk level.

In a descriptive manner, it can be assumed that both the level of risk and the level of security require quantification of threats (frequency of their occurrence) and their potential consequences (Zaskórski, 2011), when the risk materialises, or require the possibility of counteracting the risk by determining the chances and vulnerability (immunity of the system, man, social group) to a specific type of threat (or a situation triggering the threat). One possible model for such an evaluation could be a "spot" model, where the level of risk:

$$VaR = P \times S \times D \times E$$

whereby: VaR - risk level, P - frequency of the threat, S - effect (level of losses), D - vulnerability to risk (e.g. pandemic in winter or in other seasons, humidity,

[12] https://www.newsweek.pl/biznes/jerzy-hausner-jak... *(accessed on August 24, 2020)*

climate, etc.), E - exposure to the threat (e.g. for elder people in the case of COVID-19).

Another, more intuitive model of risk evaluation may be the rhomboid model (Senhar, Dvir, 2007 pp. 63-138), which defines the risk level as a field of a rhombus stretched in a coordinate system with four opposing directions, such as: X1 - rate of threat propagation (effects' propagation), X2 - intensity of infections' detection, Y1 - diversity of factors causing the infections (overlapping effects of different diseases), Y2 - diversity of infected population (age, occupational, environmental). The level of risk can then be quantified as the product of the coordinates (X1, X2, Y1, Y2) respectively:

$$VaR = (X1 + X2)\,(Y1 + Y2)/2$$

A certain generalisation of both models may be the risk co-incidence matrix model (e.g. "home" of risk) as a simplified emanation of the so-called QFD method-Quality Function Deployment-, (Zaskórski, 2012), which is based on the identification of risk factors (columns of the matrix) in a compressed layout (with the possibility of specifying risk factors in a given group of threats). The rows of the coincidence matrix may illustrate the effect of the materialisation of a given threat (or individual factors) and then a level of risk or a level of a chance of counteracting the risk can be estimated and then the value determined can be interpreted as the safety level in the given threat class (Da Veiga *et al.*, 2020).

The Pareto-Lorentz method (Zaskórski, 2012) may be an important detailing of such a model of risk estimation, considering different classes of effects. It allows to rank the levels of risk and determine (according to the 80-20 rule) the dominating zone for which 20% of risk factors decides about 80% of the level of effects caused by a given class of threats. This means that each threat has its rank according to the level of effect it may trigger. The higher the impact on risk, the more important this factor is. The level of risks and threats is becoming a saturated curve, growing more and more slowly. This way, it is possible to carry out a fairly precise analysis of the risk factors and focus on those that strongly influence the level of risk.

This may be an important means of modifying the strategy of the services responsible for health security. In an analogous way, the value of opportunities for risk prevention can synthetically be specified, e.g. by increasing situational awareness through the implementation of new information technologies. It then becomes possible to set the level of health security as a complement to the risk level. The lower the risk, the higher the level of security.

The implementation of quantitative and qualitative methods in risk assessment requires deeper verification of the situation data and a more precise picture of the crisis situation. This concerns in particular the specification of threats and effects in particular areas of the functioning of society and the State/Government, including,

among others, education, the labour market, state and protection of the environment, retail and wholesale trade and services, fuel and energy management, transportation and telecommunications, culture and the arts, science and technology, health and health protection, industrial production, social economy, national defence, the judiciary branch of government, social aid, construction by developers, municipal and housing infrastructure, living conditions of the population, demography, agriculture and forestry, foreign trade, finance, as well as tourism, sport and leisure and arranging the State/Government and local government structures. Risk assessment should therefore be considered in the context of the threats and effects in each of these areas caused by COVID-19.

A protracted pandemic without verification of the actual level of situational awareness will imply economic problems in particular. The protective mechanisms implemented by the authorities (e.g. so-called anti-crisis shields) may not eliminate the effects of the COVID-19 threat. Some citizens may gain temporary cover at a minimal level, but it will be difficult to predict the prospect of a way out of this crisis. This is why it is so important to collect and select data on threats and their effects not only on a local level. The feeling of security is becoming an important factor in the state of situational awareness and in the objective assessment of the effectiveness of legal regulations and the anti-crisis actions of authorities.

One of important factors increasing the risk of health loss may be the bureaucratisation of usage of various forms of the government's aid. Aid should arrive quickly, without unnecessary formalism, which is probably conditional on the need to identify and monitor risks and their sources in advance and at ongoing basis. Quite often immediate decisions are required[13]. Of course, such decisions require appropriate measures. Various instruments should be used, including the role of local authorities and their organisational and financial capacity. The competences of these authorities can limit the level of chaos and stabilise the desired situational awareness level. What is needed then is simple messages and an unrestricted flow of information about countermeasures. Dedicated, authorised communication by people of appropriate trust and authority is important here.

One of the worse strategies for dealing with pandemic risks is to try to underestimate threats and quite often over-optimistic forecasts for the economy, driven by social demand. As has already been mentioned many times, the process of creating society's situational awareness requires a clear statement of what difficulties the authorities see and what stuff citizens are entitled to expect from those in power, but also what those in power expect from citizens. What is important here is that the interaction between authorities and society is important. Effectiveness of actions is here a function of trust, cooperation and

[13] *For example, President Macron said that citizens do not have to pay their electricity or gas bills from the first days of the pandemic.*

understanding[14]. It is therefore important to learn from others' mistakes and experiences, especially in terms of forecasting the effects and needs for protective measures. For example, the business entities on free market can benefit from such situations and offer protective equipment at speculative prices. This gives rise to costs that are putting the budgets of individual local institutions and the whole country under strain. Optimisation of the manner in which the budget is used becomes one of the opportunities to increase potential and possibilities of action

The COVID-19 crisis reveals shortcomings in various areas, particularly in health and education. It is becoming necessary to remove obstacles and decentralise decision-making processes according to the adopted operating procedures, modified for the time of the crisis and assigning them - according to the state of the situational awareness - to lower levels of management. It is becoming a requirement to implement framework regulations by governments, but the processes for meeting the needs of protecting society should be the domain of local institutions and local levels. Subordinating such activities to a single decision-making centre may multiply the level of risk and delayed responses to an existing threat.

Situational awareness of the population and local institutions is a necessary condition for people not to feel exempt from active cooperation based on entrepreneurship, resourcefulness, and foresight. Unlocking such potential is the greatest opportunity to counterbalance the risk of loss of health and life. This state of affairs cannot be achieved without a proper information process and confidence in the information provided. Education and ongoing, reliable information increase the level of trust between the citizen and the authorities and between citizens (social groups) and the resilience of the crisis management system to disruptions. It is worth saying at this point that the crisis caused by COVID-19 on a global scale is making significant changes in the mentality of people and entire societies. Awareness of health risks and methods of counteracting their materialisation in people's lifestyles will probably imply a restructuring of business processes in companies to move some services to an employee home permanently.

Many economic entities and even entire countries may lose a large part of their potential in certain sectors. This certainly applies to the tourism industry. This is a direct result of the possibility of materialising health risks associated with COVID-19. There must therefore be a change in the value system towards a perception of the alternative use of the resources accumulated. Hence the importance of information about the location and assortment of resources and the possibility of using them for other purposes. This way it is possible to build real resilience for the entire system of country management, not just in crisis situations. This resistance is

[14] *The good example are e.g. Spain citizens, which received the message that they could stay at home until the end of April this year, and that every employee would be paid 100% of their salary.*

also an important attribute in responding to threats of various dimensions.

Ensuring informational operation continuity and efficient information processes and systems are becoming a condition for increasing resilience level. Their implementation may result in significant changes in the functioning of public administration and the whole country. The operating model should be based on informationally and functionally integrated processes and IT systems and should strengthen situational awareness in the anti-COVID management system of each country.

5. Raising Situational Awareness versus Information Technologies

The concept of counteracting selected risk factors that reduce the health security of the population under COVID-19 conditions should be based more strongly on the process of creating situational awareness of the population through using modern information technologies. These technologies make it possible to share uniformly formatted and verified data. This requires the use of IT platforms and tools linked to them. Apart from autonomous systems enabling the recording of current facts and events (OLTP systems[15]) in the local dimension and classic historical data warehouse systems (OLAP systems[16]) - the possibilities of collecting information about various objects (patients) and their analysis for the needs of crisis response processes and related decision-making processes, become important. Simulation tools and models can also be important and useful, especially in forecasting and verifying data on threats and their consequences.

Modern solutions, and in particular the concept of the Internet of Things (IoT[17]), can be particularly useful in monitoring the health of a selected group of people. Under the COVID-19 threat, it would become important to collect parameters that would signal the level of critical attributes that are symptoms of the disease in people with an increased risk gradient. This technology assumes the connection of people and things (devices, machines, products) into a single network, in order to create a system providing products and services that are modern in terms of quality and, above all, providing information collected and recorded by sensors of the assumed intelligence. The development of IoT is related to the emergence not only of new things, but also of a new dimension of monitoring the condition of any facility and the threats associated with its normal functioning.

The collected data can be exchanged between objects (e.g. patient-doctor) on-line (direct communication). Such communication may include two types of connections concerning the exchange of information between people and objects

[15] *On-Line-Transaction-Processing*
[16] *On-Line-Analyzing-Processing*
[17] *Internet-Of-Thing*

(systems) and between objects (including machines[18], products) without human intervention. Products (objects) enriched with appropriate tools (e.g. temperature sensors, other sensors, etc.) thanks to such connections will be able to generate appropriate information about one another and exchange such information with one another in order to effectively enable the process of monitoring their condition or the state of threat to a given object. This way of monitoring symptoms can be part of a more general e-health system in the full cycle of estimation and assessment of health threat risk[19] and can provide selected recipients with a comprehensive assessment of the situation identified by the system, including a wider range of monitored facilities (patients).

From the point of view of minimising health risks, the aspect of reducing direct contact between patients and the larger number of people in healthcare facilities becomes important here. The implementation and use of the IoT platform in modern health care systems can be regarded under COVID conditions as the necessary condition for the rational behaviour people belonging to the group with an increased risk of developing an illness. The implementation of IoT tools in healthcare systems is becoming its driving force for the construction of integrated, intelligent healthcare systems with no time or place limits.

The area of application of IoT technological solutions is already quite significant and shows great dynamics with the development of newer and newer technological proposals in the area of new materials and solutions in the IT world. The strategy of modern industry (Industry 4.0, Gilchrist, 2016, pp. 1-64) sets out the areas of exploration and continuous implementation of the IoT technology to keep up with the requirements and expectations of customers. The implementation environment, which is the IoT platform, is the rich base of new solutions for modern monitoring and warning systems.

Today's crisis management systems require their response to be adapted to individual requirements and to the current assessment of the situation in terms of an individual citizen or a specific group, community, or society as a whole. It also means the need to consider the high dynamics of changes and formalisation of process structures, which are able to dynamically and flexibly meet the requirements of systems to manage risks of loss of health security. The widespread use of IoT technology in human activities can be confirmed by the areas listed in Table 1.

[18] *Communication between machines is called M2M communication.*

[19] *On the basis of comprehensive products, value networks will be created, in which the IoT platform and Big Data systems and intelligent manufacturing lines, together with delivery services, will be exchanging data.*

Table 1. *Selected examples of IoT applications.*

Type of application of IoT	**Possible objective in terms of health protection**	**Areas of implementations**
Smart Life	Simplification and security of life processes	Healthcare, public service banking, entertainment, optimal time management.
Smart Mobility	Independence from the direct contractor and prevention of e.g. health/pandemic threats in communication.	Autonomous means of transport with the possibility of use in conditions of evacuation of people and property (urban mobility)
Smart Home, Smart Buildings and Smart Infrastructure	Improvement of safety and comfort of living in buildings (houses, flats, including e.g. signalling and realisation of feeding needs, etc.)	Intelligent home appliances, health monitoring, intelligent systems to manage a building and its equipment
Smart City	Improving the quality of life in the city, including health security (minimising the effects of crisis situations)	Intelligent urban infrastructure management (including health care), improvement of security, modern administration (no queues)
Smart Manufacturing, Industry 4.0	Robotisation and reduction of the human role, which can significantly enhance (opportunity) the reduction of the risk to lose health security	Intelligent, automated decision making, networked control and management of production equipment (networking) and optimisation of production and service processes.
Smart Energy, Smart Grid	Modern technologies for energy supply and billing as limiting the role of man as a carrier of epidemic threats	Intelligent management of energy systems while maintaining data security [20] at an appropriate speed.

Source: *In-house elaboration compiled on the basis of Miller M., 2016.*

The IoT platform with its innovative solutions becomes the main component of a concept that respects the assumptions of the fourth industrial revolution (Industry 4.0, Gilchrist, 2016) in many different domains. Based on the solutions in the areas mentioned earlier, there are additional opportunities to develop systems to prevent or even eliminate health risks associated with COVID-19. These opportunities are, above all, the reduction of the direct role of man in production processes, services, and other areas of activity. Therefore, e-health systems are being developed and virtualised, both in terms of remote health monitoring and administrative and hospital services.

The implementation of this class of solutions also provides an opportunity to reduce the operating costs of various entities in relation to the costs of the traditional model. This is particularly important for small and medium-sized organisations. Undoubtedly, the rapid development of IoT is a great opportunity to simplify and increase security in many areas of human life. In addition, thanks to the widespread use of applications, these solutions are becoming increasingly cheaper, quite easily accessible, and constantly developed as new material technologies are discovered and the IT environment develops.

Modern organisations in crisis situations must be flexible and adaptable in rapidly changing conditions. An additional challenge is also the dispersion of entities and resources, both human, material, and technical and also intangible. Conceptual

[20] *https://www.ibm.com/downloads/cas/Q72NLOOE, (accessed on October 9, 2019).*

basis of INDUSTRY 4.0, forces in somewhat way to implement technologically advanced devices (Gilchrist, 2016) and to collect and process a lot of data.

The epidemic situation also generates a great deal of diverse data, which must be archived and used in decision-making processes. Many types of software related to data mining can be used here. The selection of the information needed to assess the situation and plan actions, and the time when we can extract this information, is a natural determinant of the effectiveness of actions in conjunction with the appropriate level of situational awareness.

An additional premise is to process the data quickly and to ensure adequate security and confidentiality[21] of the information obtained, especially when the data comes from heterogeneous sources (e.g. a large number of different mobile devices/sensors associated with the IoT platform). The solution for such situations may be the already mentioned OLAP systems, but most importantly, there are Big Data systems with data-mining models. This class of solutions can well support both the process of creating situational awareness under COVID-19 conditions and give a comprehensive picture of the state and prospects of the development of the epidemic situation, which can significantly reduce health risks.

It is worth noting at this point that Big Data systems are a peculiar solution for collecting a large amount of diverse, multiform data (figures, text, graphics, images, etc.). The usage of systems of this class can promote the accuracy of decisions made in a shortened period of time and at a lower operational cost for anti-crisis organisations. The previously discussed concept of the 4.0 revolution (Industry 4.0) even assumes the use of Big Data technology for comprehensive assessment of the situation in service and production systems and systems supporting management under difficult conditions. The current, ongoing relationships with the interested parties of the COVID-19 anti-crisis system should be based on up-to-date data about their needs and preferences. They are therefore becoming a standard for supporting the decision-making process in real time.

The Internet is undoubtedly a specific source of data for COVID-19 related antivirus activities, and the exploration of its information resources (Web Mining), preceded by their rapid selection with the use of a suitable Big-Data technology, may become a determinant of the population's situational awareness. It should be noted, however, that the amount of information collected in Big Data systems is growing almost exponentially and is multiplied by a growing number of mobile devices. The success of this class of ICT applications is not only based on the process of collecting and analysing large amounts of data or the ability to access detailed information but is closely linked to the rapid development of interactive applications.

[21] *https://www.ibm.com/downloads/cas/Q72NLOOE, (accessed on October 9, 2019),*

These applications - in line with the idea of Industry 4.0 - communicate between systems/objects and can reinforce autonomous actions based on current references and analyses of current information resources of their own and from the global environment. Applications already available today reach for concepts and models of discovering knowledge not only about the state of emergency, but also about predicted behaviours and developments (neural network models and fuzzy sets) in order to support the processes of preventing their effects. What is important here is the selection and delivery of exactly the required amount of data to the indicated recipients, who create appropriate decisions and launch targeted actions.

The INDUSTRY 4.0 concept recommends the versatility of solutions and the use of open technologies with the possibility of their expansion, which is an important attribute for the interoperability of many COVID-19 crisis management systems. Such scalable solutions can provide an additional boost to the development of a global system that can integrate informationally various, dispersed entities. Today, according to Infogroup's research[22] 62% of marketers around the world declare that they use marketing with the help of Big Data. This shows that business-oriented solutions can be suitable for the effective exploration of data on the states, intensity of change and prediction of the effects of the COVID-19 epidemic through using multi-faceted data analysis models. Among the many different solutions, it is worth quoting the whole family of simulation systems as tools for effective forecasting and verification of situation assessment.

Simulation systems and models require the supply of relevant data stored in various databases and data warehouses. In crisis management systems, COVID-19 can act as a verifier of planned actions. Forecasting and simulation are well-known techniques supporting various decision making processes (Zacharias et al., 2008, pp. 89-118) both in economics, transport and management of organisations in general (Gajda, 2017, p. 16) as well as in management of various areas of human activity. Effective forecasting of events, of the course of various processes and their states as well as of the effects of specific events can significantly prevent losses associated with wrong decisions in any organisation.

Crisis management processes under COVID-19 conditions involve the efficient use of resources to achieve predefined objectives. In an era of globalisation of health risk factors and dynamic changes in the picture of the effects of a pandemic, the generation of multiple scenario variants for courses of specific processes is an activity that supports the analysis and selection of strategies for action appropriate to the situation. The information resources obtained in the processes of simulation about possible threats, their dynamics and effects gain the status of a resource of high value. It can be said at this point that making effective decisions requires

[22] *https://www.erp24.pl/rynek-it-swiat/5-kluczowych-systemow-big-data-na-swiecie.html (accessed on October 12, 2019, 5 key Big Data systems worldwide. - ERP 24.pl, Portal of IT solutions in business)*

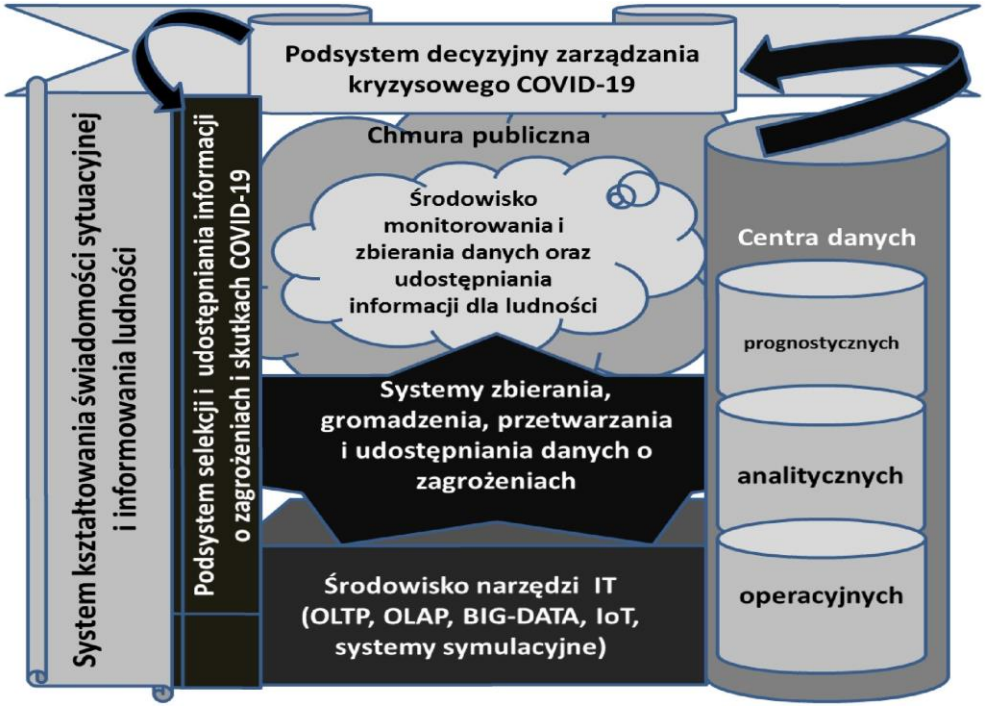
access to appropriate, interdisciplinary information, and the crisis situation resulting from COVID-19 confirms this multidimensionality of causes and effects.

Podsystem decyzyjny zarządzania kryzysowego COVID-19	Decision making subsystem of the COVID-19 crisis management
Chmura publiczna	Public cloud
Środowisko monitorowania i zbierania danych oraz udostępniania informacji dla ludności	An environment for monitoring and collecting data and making information available to the population
Systemy zbierania, gromadzenia, przetwarzania i udostępniania danych o zagrożeniach	Systems for collecting, gathering, processing and sharing data on threats
Środowisko narzędzi IT (OLTP, OLAP, BIG-DATA, IoT, systemy symulacyjne	IT tool environment (OLTP, OLAP, BIG-DATA, IoT, simulation systems)
System kształtowania świadomości sytuacyjnej i informowania ludności	System to shape situation awareness and inform the population
Podsystem selekcji i udostępniania informacji o zagrożeniach i skutkach COVID-19	Subsystem for selecting and sharing information on threats and effects of COVID-19
Centra danych prognostycznych analitycznych operacyjnych	Centres of forecast data analytical data operational data

Effective management processes should be analysed both from the perspective of current (operational) data and through using the principle of analogy also in relation to historical data describing similar past events (Figure 2). Therefore, the content of information resources concerning the forecasted activities (information and foresight data) should be enriched and verified through the use of tools that give an opportunity to assess the level of credibility of the picture of reality awaiting us against the background of the evaluation of the past. Simulation methods and systems refer precisely to certain rules derived from past observations and, against this background, can generate and supplement data in the operational resources of a given decision-making level.

Simulation systems are therefore tools to ensure imitation of a certain process (e.g. the process of spreading a virus or eliminating selected effects, etc.) or the behaviour of a system of operations with the possibility of geo-spatial visualisation of the situation (GIS systems) through the use of advanced software applications, platforms and IT environments. It is therefore possible to present and verify, at the level of a (usually simplified) model of operations, a specific situation, described by a large number of data in a fairly short time.

Figure 2. *The integrated system to inform the population on the emergency COVID-19 related situation*



Source: *In-house elaboration.*

Very complex tests and trials on real objects, which lasted several years and were unfortunately costly, can be replaced by a probably simplified simulation model generating similar data in much shorter time (e.g. several days, hours or minutes) depending on the available computing power of "simulation systems". An important advantage is also the possibility of extending the system's time of operations when there is a need to examine the dominant (selected) attributes of a given, highly variable operating structure or the course of a simulated process, which may be difficult and laborious to observe in real time.

Moreover, unlike traditional forecasting methods that use formal (mathematical) models, which, when changing input parameters describing states of a given process, significantly extended the calculation time, simulation models are characterised by a slight increase in the time of obtaining results. It is worth noting here that the results of simulation studies can be considered as a source of supplementing analytical data and can be collected and stored, analysed, and compared (e.g. in OLAP system technology or Big Data systems).

An important feature of simulation systems is also the possibility of repeating experiments several times under similar or identical conditions. The previously mentioned possibility of visualising analysed situations in virtual reality becomes

an important factor in enriching situational awareness. This aspect may be particularly applicable in forecasting the course of fast-changing processes, in which it is important to quickly perceive the trends of changes determining the decision-making cycle in a specific crisis situation.

By using models and simulation systems, it is possible to forecast the full "life cycle" of specific objects, to study their states and possible disturbances in their operations. An important difficulty for this class of methods and techniques to help counter the COVID-19 crisis - even though we can test most systems without major limitations through using simulation models - may be the accuracy of the representation of reality. However, with the development of IT technology, the creation of models is becoming increasingly easy with a clear tendency for the simulation model to be more relevant to the real pattern.

Such a barrier is being eliminated more and more effectively. Simulation systems and models are an important complement to the available IT technologies, which can support not only multivariate forecasting of the future related to the COVID-19 virus, but also provide a back-up for other technologies requiring the supply of data of particular value and quality. It is assumed that, under the conditions of the fourth industrial revolution, we will increasingly refer to virtualised reality, and advanced simulation systems are an essential part of this reality that can be described more and more faithfully.

At the same time, it is important for the results of such research to permeate the awareness of potential audiences, which may enrich the situational awareness of the population under COVID-19 conditions and the possible actions of decision makers and society behaviours. Hence the concern to limit the information exclusion of an average citizen.

6. Cloud Computing and Reducing Information Exclusion of the Population under COVID-19 Conditions

Referring to advanced IT technologies (IoT, Big-Data, simulation systems) supporting various decision making and implementation processes, the information links that determine getting the desired level of situational awareness are of particular importance. One of the conditions for creating situational awareness is unlimited access to information resources and services. Access to Internet services is becoming the dominant determinant of effective counteracting informational exclusion of individuals and small entities (business organisations, social organisations, etc.).

The implementation of new technologies, especially in the area of IT, is still expensive. This is why we strive to implement such technologies that provide services and products tailored to the needs of modern customers. In an era of technological development and increased opportunities for action, awareness of

information needs is growing significantly. Thanks to IT technologies, it is possible to access many advanced solutions and results, which can eliminate information asymmetry between the decision-maker (manager) and the contractor (individual recipient).

The picture of epidemic threats and their consequences in the consciousness of each recipient of such information is conditioned by the multiple links of often dispersed stakeholders, characterised by their rapid adaptation to changes in the health care environment. The recipients of this class of services expect the health system to be flexible, agile and open to change, which is often dictated by arising social consequences. The key to meeting such expectations is to distribute the proper information and knowledge at the proper place and time. The informative preparation of a health care and crisis management system in a pandemic is therefore the basis for success in combating its effects and reducing threats. These criteria are met by the so-called CC/Cloud-Computing technology (platform), which enables access to many services and information resources without additional investment in costly closed IT infrastructure (based on: Basole and Park, 2019, pp. 370-379; DaSilva *et. al.*, 2013, pp. 1161-1173; Vijayakumar and Arun, 2017, pp. 129-136).

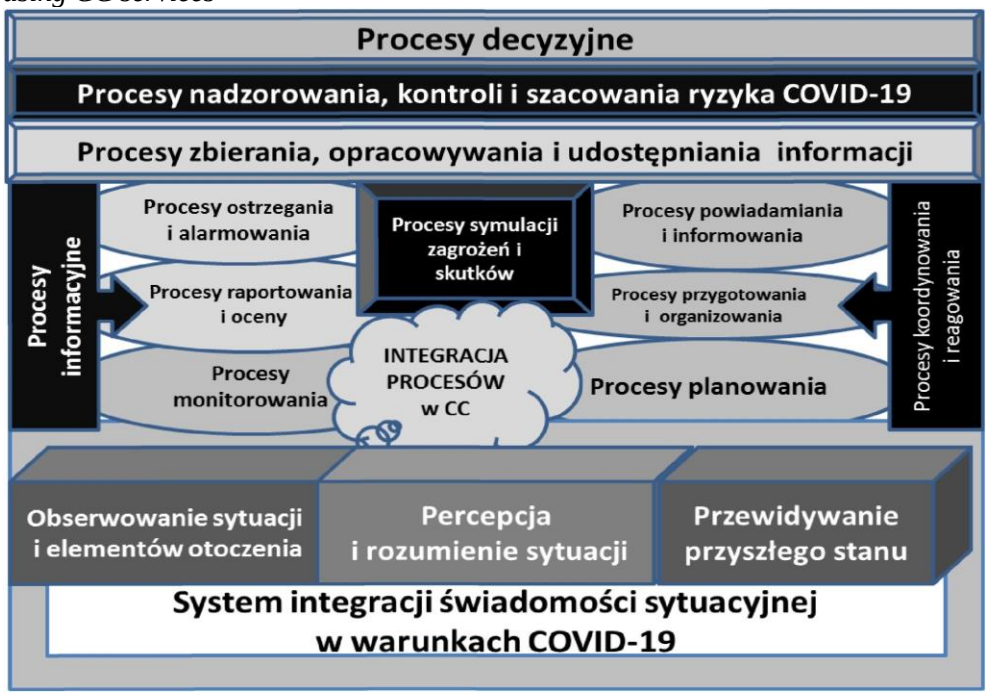
The CC platform is a complex system for delivering computing services (servers, databases, networks, software, models, and tools for data analysis, including artificial "intelligence" models, etc.) over the Internet. What is important here is that the customer only pays for the service provided, without the costs associated with creating his own, often complex IT infrastructure. The COVID-19 virus prevention systems can gain a lot from using the CC platform. The benefits can be mutual for both a potential patient and for crisis situation managers. The way, scope and form of presentation of up-to-date information with access without time and space limitations may effectively complement other possibilities of shaping situational awareness (Figure 3). Moreover, the services offered in the cloud make it possible (Chowdhury, 2018) to:

- Reduce expenditure on purchasing, configuring and maintaining the necessary hardware and software,
- Provide flexible scaling by providing the proper amount of IT resources (e.g. more computing power at the required time and place),
- Improve speed by providing access in a short time to properly processed and prepared information resources using advanced on-demand services.
- Ensure the efficiency of the confidentiality of services using networks of secure data centres, where the latest generation of the most efficient software is available, including mechanisms for maintaining informational continuity of operation of e.g. the health care system.

Procesy decyzyjne	Decision-related processes
Procesy nadzorowania, kontroli i szacowania ryzyka COVID-19	Processes to supervise, control and assess risk related to COVID-19
Procesy zbierania, opracowywania i udostępniania informacji	Processes for collecting, compiling and making information available
Procesy informacyjne	Information processes
Procesy ostrzegania i alarmowania	Warning and alerting processes
Procesy raportowania i oceny	Reporting and evaluation processes
Procesy monitorowania	Monitoring processes
Procesy symulacji zagrożeń i skutków	Processes to simulate threats and their impacts
INTEGRACJA PROCESÓW W CC	INTEGRATION OF PROCESSES IN THE CLOUD COMPUTING
Procesy powiadamiania i informowania	Notification and information processes
Procesy przygotowania i organizowania	Preparation and organisation processes
Procesy planowania	Planning processes
Procesy koordynowania i reagowania	Coordination and response processes
Obserwowanie sytuacji i elementów otoczenia	Observation of the situation and elements of the environment
Percepcja i rozumienie sytuacji	Perception and understanding of the situation
Przewidywanie przyszłego stanu	Anticipating a future state
System integracji świadomości sytuacyjnej w warunkach COVID-19	Situational awareness integration system under the COVID-19 conditions

Cloud computing can be seen in several perspectives. We can talk about CC private (Private cloud), public (Public cloud), hybrid (Hybrid cloud). Private clouds are a dedicated technology for a given organisation, which is the actual service provider. Public clouds are organised by professional external providers (e.g. Google). Hybrid clouds are a combination of a private and a public cloud. CC technology can provide various types of services (Matheos, Rosenberg, 2011, pp. 169-187) such as IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service), or CaaS (Communications as a Service) or DaaS (Desktop as a Service). Each of these models exposes a different range of services, from sharing hardware, virtual environment, a selected application on the Internet to placing full customer service on the Internet with the status of a so-called “thin” user (practically without its own IT infrastructure).

Figure 3. *Hybridisation of IT services and reduction of information exclusion with using CC services*



Source: *In-house elaboration.*

For a crisis management system under COVID-19 conditions, CC technology can be the tool (Chowdhury, 2018), which gives the possibility to maintain the expected operability of, in particular, vulnerable (high-risk) groups, taking into account the required level of security and situational awareness. It also gives the opportunity to act effectively by using representative data and analysing it quickly and making it available in a communicative form with no time or space limitations. Among the CC services, there are also advanced services for the exploration of large data resources (Big-Data) and a wide range information feedings of high intensity supplies that utilise the Internet of Things (IoT). These are tools that can closely and effectively link interested parties of health care system to decision-makers in the anti-epidemic system.

7. Conclusions

The continuity of the anti-epidemic protection system should be an integral attribute of its capacity and effectiveness of this system operations in a variety of crisis conditions. Operating with a correct, up-to-date, and reliable information is a prerequisite for effective activity. Therefore, informational continuity of activity should be treated as a determinant of the level of situational awareness. The modern determinants of situational awareness in the COVID-19 threatening

conditions are connected with the process of constant education and effective information not only about threats, but above all about the effects of those threats at the moment and in the long time period.

IT tools and platforms increase the chances to achieve an appropriate level of situation awareness through multidimensional risk evaluation and ongoing monitoring of various events and threats. The coordination of the activities of many people with appropriate, individual executive and management competences on the basis of uniform, communicative information may increase the level of synergy in the COVID-19 crisis management system.

The paper attempts to show that it is possible to create a comprehensive system for counteracting the risk to lose health security associated with COVID-19 by using solutions that increase the level of reliability, quality and effectiveness of information services.

These solutions include Cloud Computing services and large data collection systems and data mining models. These systems can be supplied with representative and reliable data through the increasing use of the Internet platform and the Internet of Things, as well as simulation models that can dynamically enrich analytical systems with predictive data and verify the predicted state of the resources needed for an effective crisis response.

Situational awareness and informational continuity of operations may reduce the risk of implementing certain types of threats, which is particularly important under the COVID-19 threat conditions. The importance of the mobility of IT solutions and the need to reduce the so-called information exclusion should also be stressed here. The continuous monitoring of the situation, the development of current messages and information addressed to the population, and also successive risk assessment of the various phases and processes of crisis management become the basis for effective, interactive activity. A comprehensive assessment of the possibilities (available resources) and needs for the selected strategies of actions can increase public confidence and the sense of health security of the population.

Modern organisations in crisis conditions should effectively assess - at various time horizons and at various stages of development of the health situation - the potential and real possibilities for actions by using the potential of their environment, taking into account access to selected resources, as well as information services with fairly strong financial and technological constraints.

Modern IT environment enables effective implementation of information and decision-making processes with the use of standards and resources located on the Cloud Computing platform together with access to Big-Data technology and ever newer tools and simulation techniques. In addition, many business models (including OLTP/OLAP/DM/Big Data class systems) can be used to ensure the

continuity of the health care system under COVID-19 conditions and maintain an appropriate level of situational awareness. This creates the prerequisites for guaranteeing the coherence and integrity of distributed activities using a virtual environment with mobile information services, with no time or space constraints.

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