# Concept and Models of Information Application for Actions in Systems

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***Abstract*—The article attempts to close a multidisciplinary gap between the need to solve problems in using information for further actions in various systems (i.e., mathematical cybernetics and theoretical systems-related problems) and available theoretical and mathematical means to solve such problems. The purpose of the article is to overcome this gap. For this reason, the concept of information application for actions in systems is suggested. Then, corresponding diagrammatic models of information application are built. Diagrammatic models presented can be used for further formalization and future research. Such formalization is possible through creation, based on the diagrammatic models suggested, the graph-theoretic models, labeled graph-theoretic, and then functional models. Such formalization opens the road to the formal description of a series of effect execution actions and possible chains of changes due to various information processing results. Such chains are modeled as chains of information actions and caused by them realizations of effect execution actions. Schemes suggested in the article were used to estimate the system's potential indicators regarding information application for actions in systems.**

## I. Introduction

The article provides the concept of information application for actions in system. Based on this concept, schemes of information application for actions in systems are suggested. Based on such schemes we suggested building diagrammatic models of information application for actions in systems. Some examples of such models are explained.

Diagrammatic models presented used for further formalization through creation (based on the diagrammatic models suggested), the graph-theoretic models, labeled graph-theoretic, probabilistic graph-theoretic, and functional models. Examples of such models can be found in [1]–[4]. Such models allow the mathematical modeling of information application for actions in systems. Modeling the use of related information technologies for actions in systems becomes possible. Such modeling objective could be the quality of information actions application for actions in systems indicators estimation. Next, such indicators could be used for information actions synthesis. Indicators of the quality of information actions application for action in the system can use previously developed indicators of the system potential [5]. In this paper the concept and models of information application for actions in Systems are suggested. The Section II presents background and motivation for research. The Section III concepts and schemes of information application for actions in systems discussed. In the Section IV of the paper concepts and schemes of information actions use in systems functioning considered, with further discussion in Section V and then concluded.

## II. Background and Motivation

The article is based on an earlier review of the literature on digitalization, digitalization in contemporary society, its digital economy, and particular organizations. A few thousand articles was reviewed as a result of recursive searches with the following major keywords: “digital capability” [6], [7], “digital platform” [8], “digital entrepreneurship” [9], [10], “emerging systems” [11], “business value of IT” [12], “digitalisation capability” [13], “organisational capability” [14], [15], “circular economy” [16], “digital capabilities” [6], [17], “dynamic capabilities” [18], [19],“sharing economy” [20], [21], “action theory” [22], “network science” [22], [23], “language-action approach” [24], “dark side of IT” [25], “real options” [26], “constructor theory of information” [27], [28], “sustainable economy” [19], “emerging systems” [29], “system of systems” [30], “digital culture” [31], “action research” [32], “Industry 4.0” [33], “blockchain technologies” [34], “AI digitalisation” [35], ”Labour digitalization” [36] , ”Big Data Analysis” [37].

As a result, we identified theories and mathematical techniques for information use modeling in various systems activities and major sources of publications on the theme considered.

The most popular journals in which the reviewed articles were published were: ”the International Journal of Information Management”, ”Management Information Systems Quarterly”, ”the Journal of the Association of Information Systems”, ”Information Systems Journal”, ”Information Systems Research”,

”the Journal of Information Technology”, ”the Journal of Management Information Systems”, ”the Journal of Strategic Information Systems” and ”the European Journal of Information Systems”.

The systematic literature review on the problems of digitalization of the economy and society concluded [38], [39] that the new theoretical formal discipline of information application for actions in systems is urgent nowadays. This discipline shall incur actions mathematical modeling, big data about actions performed using the information of the various kind, and machine learning algorithms to build models of information application for actions in systems. In [40] author shows that information technologies' role in system action is that - they allow to justify, predict, and then organize and implement various types of changes in actions of economic, social, and societal systems in general, whereas such need in change manifested. As a result, digital technologies make it possible to implement possible system activities changes or corresponding modes changes that were previously impossible or not justified. As a result, modeling information application for actions in systems allows making progress in solving the various practical problems of the system activity organization and performing. In the future, based on concepts and models developed, it is possible to automatically implement new information technologies for better forecasts of system activities with better accuracy for longer planning horizons with digital technologies, such as but not limited to: big data, internet of things, and machine learning. Based on the conducted review, the authors concluded that the existing theoretical means of studying digital technologies for actions in systems (especially mathematical models and methods for solving problems of such technologies used for actions in systems) are developed insufficiently well.

In this regard, within the theory of the information application for actions in system, theoretical means of studying digital technologies use in system action based on mathematical models and methods should be created. According to the review results, these tools and the means of the theory of the information application for actions in systems could be based, among other theoretical tools, on the process science and the theory of activity. In addition, it is promising to use extensions of the complex dynamic graph's theory, the alternative stochastic graphs, graphs of cyclograms, and the alternative partially ordered sets to represent sequences of information application for actions in systems through time.

## III. Concepts and Schemes of information Application for Actions in Systems

System actions are divided into two main groups. It is (material) effects execution actions and information actions. They differ in their goals: effects execution actions intended to obtain changes in substance and energy, and information actions designed to obtain information changes.

Effects execution action is an action made by humans, organized by humans, or – under their control (by some technical devices) to obtain material results demanded by humans (i.e., effects). Such effects manifested due to the exchange of energy and substance according to human's desire, or/and under human's control, or/and according to human's plan performed. Such exchange shall be considered in time and space.

According to the concept suggested, for such action to be executed and effects obtained, information of various kinds is required. Such information is required due to human actions' nature, which requires operation and / or exchange of various facets of reality reflections in order to conduct action successfully.

For the successful execution of actions, humans need to be sure: to begin action with required objects of the required quality, which set in required relations with other objects of interest; to begin action in certain conditions, represented as requirements to descriptions and measurements (states) of objects used in action, and to prescribe information required to act; to check states during action execution and their conformance to action prescriptions; to provide required impacts on objects and their relations during action fulfillment, according to checked states and relations of the objects used for action; to predict effects of action execution and their correspondence to requirements; to move effects received for the possible use in other actions or by other humans, through space and time.

Such requirements met with information processing during action execution. They classify into three main classes: obtaining descriptive information about objects of action, about their relations, and characteristics (i.e., sensing descriptive information from objects and their relations, information processing of ”in” kind, i.e., from objects); receiving, operating, and sending information from/to the information sources (i.e., processing information of various kind without action objects affected); using the information to provide required impacts on objects, and their relations during action fulfillment, described by this information (i.e., actuating prescriptive information, kind of information processing of ”out” kind, i.e., to objects).

Subsequently, three kinds of information processing for the execution of action effects are distinguished. Further, three kinds of information processing per se (not ”in” or ”out” type – i.e., without the participation of objects used for effect execution) distinguished.

Such information processing (without the participation of objects used for material effects execution) classifies as the processing of three kinds of information. They are descriptive (hindsight, answering ”what happened”), prescriptive (insight, answering ”how to make it happen”), predictive (foresight, answering ”how do we make it happen”) information, and combinations of them.

Predictive information processing differs because it does not necessarily produce information about particular action objects used for effects execution. It makes higher-level information. Predictive information is general information about why effects manifest and how – not only in specific action execution cases and with particular objects and information used for that. There could also be other higher-level types of processing information, which do not necessarily reflect the effects of actions. Such higher-level information processing is a kind of information processing for obtaining explanations, rules, peculiarities, and prediction of use of objects results formation, general laws of nature functioning, their descriptions, and so, predictions formation as of different actions fulfillment, different human requirements formation rules, as well as, probably, other levels of explanations. Such explanations formed as knowledge about different ways of human and nature activities and other phenomena' formation, their details, because of actions of humans and nature. This article does not consider processing information of these higher levels kinds yet. It is subject to future research.

As the authors noted previously, information processing during effects execution actions should be distinguished in time (before, during, after actual effects execution) and in space. For this reason, various kinds of synchronization models are provided, like cyclograms models for time synchronization among actions or technological routes for modeling moving material entities and energy in the space.

In figure 1 effects execution action represented with rectangle in the center with ovals segments attached, which represents information processing parts of effects execution action and circle outside which represents the attached effects prediction information operation:

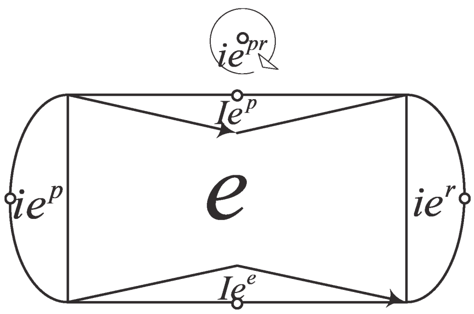


Fig. 1. Effect execution action schema and information application in it

$ie^p-$ execution prescriptions information ($Ie^p$) processing can be performed before the start of the execution process. This kind of information processing is shown as an oval part. Its result consumed during the action is shown as a triangle with direction toward action.

$ie^r-$ effect execution monitoring and reporting information ($Ie^e$) processing can be performed after the finish of the execution process. This kind of information processing is shown as an oval part. Its result consumed during the action is shown as a triangle with direction toward action.

$e-$ effects execution action, between $ie^p$ and $ie^r$; Information processing for executing action is required [41] in the case when action is either new (new means different from previously performed before the effect execution action start) or it shall or could be changed at or after action start.

$ie^{pr}-$ is effect execution prediction information ($Ie^{pr}$) processing can be performed at any time with or without effect execution action. This kind of information processing is shown as a circled arrow above effects execution action. This information processing can consume all kinds of information considered before. Its result can be consumed during any information processing considered before.

If action is new, information about its various aspects shall be obtained to fulfill an effect execution action. If such information is already known and received before the action starts and is not subject to change, other information is unnecessary. If action shall or could be changed at its start information to fulfill an effect execution action still required, like in new action case.

As a result, information processing could be classified, based on information processing for effects execution actions classification suggested, as five main ways of information processing for effects execution action and their combinations for the first level of information use. Among these two information processing kinds are, in fact, information "in" processing (sensing) and information "out" processing (actuating) – i.e., information processing "on the border" with effect execution action objects. The other three kinds are descriptive, prescriptive, and predictive information processing. But descriptive information processing is related to sensing information processing because descriptive information could be obtained through sensing information processing and from other sources outside action considered, for example, through information exchange. Similarly, prescriptive information processing is related to actuating information processing because such information is used by actuators but can be processed not only by actuators. Thus, among three kinds of information processing for effects execution action, two caused by other two, related information processing on the border.

The third information processing kind, predictive information processing, differs from the four kinds considered above. It is information processing of higher-level, as the author described earlier. Such information processing uses information of all possible kinds (all four types already considered) and information from outside to synthesize foresight information to predict future effects. Predictive information can be further used to synthesize descriptive and prescriptive information and for corresponding information processing. Like with other information processing cases, such information can be used in case action changes or could be changed.

We show such possibility with an external circled arrow which may connect each information processing kind.

Depending on the results of the classified information processing results (i.e., information of various kinds), required if action is new, or changed mode, or could be changed after particular action with particular mode starts, the action will result in different effects, and further correspondence of that effects to the demands will manifest differently. But this correspondence is required to obtain the needed quality of the action. Thus, the quality of effect execution action depends on information under the necessary condition effect execution action changed or may be changed due to some reasons: changing environment changed action objects characteristics, or changed relations between objects changed goal. Such dependence opens the road to describing a series of effect execution action possible changes, chains of changes due to different information processing results. Such chains could be modeled as effect execution – information actions chains.

### A. Examples of Information Application for Actions in Systems

Let us consider three simplified cases of information application for actions in the system. In each case, the source of uncertainty situation is the environment. It changes effects execution action course and its results. Thus correction of effects execution action mode is required. After such correction, made using information actions, effects execution action repeats in a new mode, and contour of actions repeats in a new situation.

The first case is responding to system environment changes. Such changes may lead to different effects on execution system action results. Let natural numbers enumerate all such possible results with the use of classification. We suggest the tabularly set function maps each enumerated result of environmental change into the number of further effects execution action mode. Information actions, in this case, involve the classification of effect execution action results to represent it with a particular number. Then, performing a tabularly set function of this number to obtain further effect execution action mode number. Then, providing prescriptions for effects execution action according to the mode of action number obtained. Then contour of actions repeat, i.e., effects execution system action results classification made again.

The second case of information application for actions in a system describes the reaction to environmental changes, which differ from the first case. The difference is that needed reactions can not be constructed before environmental change happens. Thus, information action will develop such reactions after new environment changes occur and a new class of effect execution action results manifest. A new kind of information action is needed to react to such newly obtained results, not classified earlier. Information action develops prescriptions for new (not yet designed before) effects execution action mode, reaction to new results manifested. Then effect execution action is performed according to prescriptions for the new action mode and contour of actions repeated.

The third case of information application for actions in the system describes the system's reaction with possible modernization actions. In this case, the first case changed with possible modernization actions for some of the effects execution actions outcomes. Such possible outcomes which require modernization are determined as a result of classification, by appropriate information action, in addition to the numbers of outcomes of the first example. Outcomes, classified as requiring modernization ones, lead to information actions of modernization planning and then information actions of providing and fulfillment of prescriptions for modernization type actions. Modernization actions are effects execution actions whose goal is to change the system. Once modernization action is finished, a new (modernized) system will perform modernized effect execution action and contour of actions repeated.

Cases considered may further be developed for situations when there are other sources of uncertainty or vagueness, such as uncertainty of actions fulfillment, the vagueness of information, vagueness when performing information actions.

## IV. Concepts and Schemes of Information Actions Use in Systems Functioning

We will define information action (i.e., action, which purpose is not effects execution, but information processing in a similar way to effects execution action in Fig. 2. Information action represented with oval as the opposite to rectangle which represents effects execution actions. The ovals segments represent particular kinds of information processing as parts of information action while circle outside oval represent information processing outside information action.

It consists of parts that execute information processing using some action object. It is shown with an oval in Fig. 2. $i-$ information action modeled. For such information action, like in the case with execution effects action, descriptive and prescriptive information, and corresponding information processing used:

$i^p-$ prescriptive information processing; $i^r-$ descriptive information processing (monitoring and reporting input and output).

$Ii^p-$ prescriptive information to process information (algorithms, code). $Ii^o-$ descriptive information (desired and actual input, output, current states of computation)

Like in the case with execution effects action, higher-level information processing is shown as a circled arrow - predictive information processing. $i^{pr}-$ is the predictive information processing (to predict information $Ie^{pr}$), which can perform at any time with or without information action. This kind of information processing is shown as a circled arrow above information action $i$. This information processing can consume all kinds of information used by information action and considered before. Any information processing of information action consumes these information processing results.

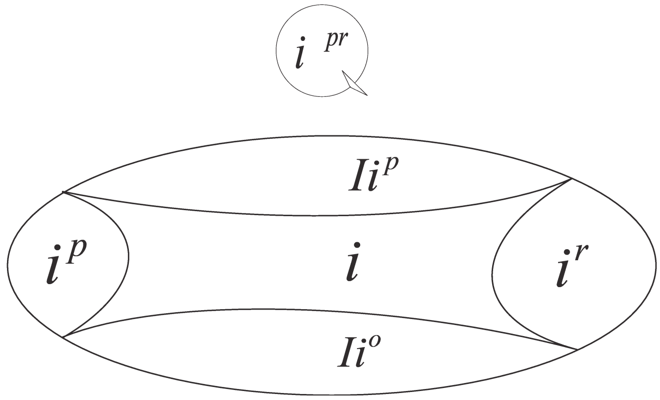


Fig. 2. Information action schema

## V. Schemes of Information Application for Actions in Systems

The researcher can further combine information actions and execution effects actions into sequences with the concept of ports and synchronization.

Port is the element of action schema with the required information, or substance/energy exchanged between objects inside and outside the port.

Information and material ports are possible. Information ports concept illustrated by the schema in Fig. 3.

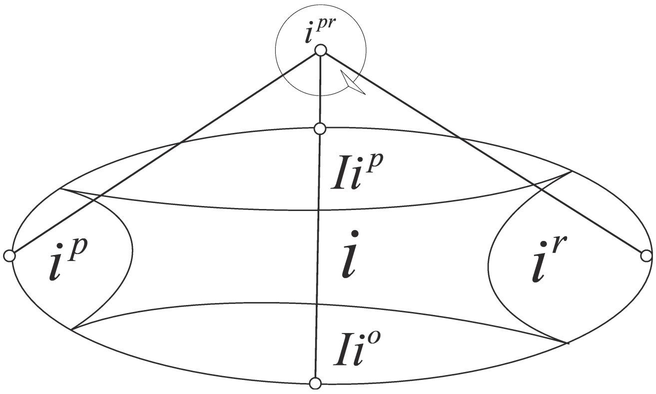


Fig. 3. Information action with ports and exchanges schema

At the schema, the predictive information processing ($i^{pr}$) (part of information action schema) connects information ports of various kinds. Such connection made because predictive information processing generally requires all kinds of information about information action used, and its results can be sent as a result to each information port.

Example of schema, constructed from elementary ones to schematize one of the possible information applications for actions in systems shown in Fig. 4.

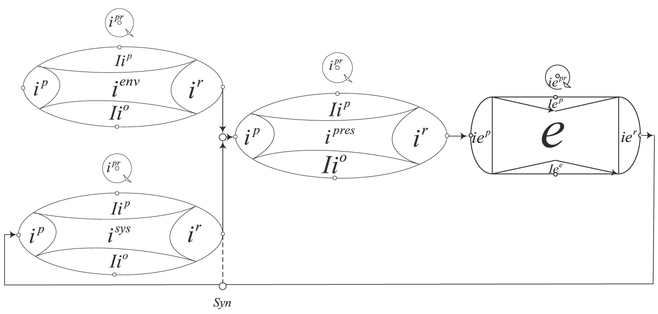


Fig. 4. Example of Information Application for Actions in Systems Schema

Schema shows three information actions designated $i^{env}$, $i^{sys}$, $i^{pres}$.

$i^{env}-$ is the information action to monitor events in the environment.

$i^{sys}-$ is the information action to monitor events at the system.

These two information actions results sent to further information action, $i^{pres}$ repeatedly, synchronized in time with $Syn$ element (e.g., using cyclogram).

$i^{pres}-$ is the information action to generate prescriptions for system actions.

This information action generates prescriptive information for effects execution action, $e$, which can be complex (e.g., a network of activities).

Information about effects of $e$ is further used by $i^{sys}$ with the use of some synchronization to ensure current effects execution action results at each moment of synchronization used to generate further prescriptions.

### A. Indicators Estimation Based on Schema Suggested

Suggested schema was used to estimate system' potential indicators in our previous works [42] with regard of information application for actions in systems.

For estimation, the researcher should generate all possible sequences of the environment changes and corresponding system action changes. Such sequences are built based on cyclograms of possible changes.

To illustrate how such models created an example of environment changes model in the tabular form shown at Tab. I.

TABLE I. Alternative Sequences of Environment States

| № | $< c_i^e > /T_z$ | $T_0$ | $T_1$ | $T_2$ | ... | $T_j$ | ... |
|---|---|---|---|---|---|---|---|
| 1 | $< c_0^e >$ | $c_0^e$ | $c_0^e$ | $c_0^e$ | | $c_0^e$ | |
| 2 | $< c_0^e, c_1^e >$ | $c_0^e$ | $c_0^e$ | $c_0^e$ | | $c_1^e$ | |
| ... | ... | $c_0^e$ | $c_0^e$ | $c_1^e$ | ... | $c_1^e$ | ... |
| n | $< c_0^e, c_1^e, c_2^e >$ | $c_0^e$ | $c_1^e$ | $c_1^e$ | | $c_2^e$ | |
| ... | ... | $c_0^e$ | $c_1^e$ | $c_2^e$ | ... | $c_2^e$ | ... |

Each cell $c_{nj}$ of the table corresponds to the model of possible system alternation at the moment between $T_j, T_{j+1}$ and is associated with needed data about the environment for such alternation planning.

Such data is illustrated in Tab.II.

Among such information is $P^a_{i,i+1}(T_j)-$probabilities of possible environment changes events $\hat{E}_{i,i+1}(T_j)$ from the state ($c_i^e$ to the state $c_{i+1}^e$ at the moment $T_j$ due to actions in the environment;

$$P^a_{i,i+1}\left(T_j, T_{j+1}\right) = p^l_{i(i+1)k}\ P^b_{i+1}\left(T_{j+1}\right),$$

where $p^l_{i(i+1)k} = f^l_i\left(T_j - T_{j-k}\right)$ - the probability that to the beginning of the interval $\left[T_j, T_{j+1}\right]$ considered there was state $c_i^e$ under condition, that this state have began at moment $T_{j-k}$ and than (under same condition) at interval $\left[T_j, T_{j+1}\right]$ this state changed to the (next possible) state $c_{i+1}^e$.

$f^l_i(t) = F\left(t^l, t^r, t\right)-$cumulative $B$-distribution function of time required to fulfill operation $a_i^e$ with left and right bounds of possible time $\left[t^l, t^r\right]$ and at the variable time $t$. $B-$ distribution used in accordance with models of actions suggested in [43].

TABLE II. (FRAGMENT). THE CHARACTERISTICS OF THE ENVIRONMENT STATE

| $P_{i,i'}(T_j)$ | $P^a_{nj}$ | $T_j$ | $T_{j+1}$ | $s^d_1(T_m)$ | ... | $s^d_k(T_m)$ | ... |
|---|---|---|---|---|---|---|---|

Probability $P^b_{i+1}(T_{j+1})$ is the probability that to the end of $[T_j, T_{j+1}]$ interval state $c^e_{i+1}$ not finished.

$$P^b_{i+1}(T_{j+1}) = P^{cb}_{i+1}(T_{j+1})(1 - F^e_{i+1}(T_{j+1}));$$

$P^{cb}_{i+1}(T_{j+1})-$cumulative conditional probability of the $i+1-$th state beginning at the moment $T_{j+1}$ :

$$P^{cb}_{i+1}(T_{j+1}) = \prod_{k=\overline{0,i+1}} F^b_k(T_{j+1}).$$

$P^a_{nj}-$probabilities of states actualization at $T_j$ due to the actions in the environment realized according to alternative sequence $C^e_n$;

$s^d_k(T_m)-$states, demanded by the environment at the border with the system. The states required at future (relative to the state of the environment) moments $T_m$.

As a result of modeling, chains $C_n$ of possible changes due to information operations of different modes and connected with them by cause-and-effect relationships effect execution action modes built.

Mode of action is interlinked by cause and effect relationships sets of its characteristics (states), which define possible course of action during it fulfillment.

Chains of possible changes corresponds to chains of states due to information actions modes and corresponding them through cause-and-effect relationships action execution operations modes states.

Such chains obtained as possible graph theoretic walks through suggested schema of information application for actions in system,

Example of such chains shown in Fig. 5.

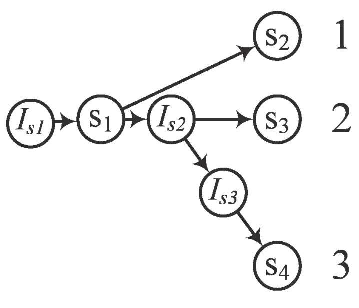


Fig. 5. Chains of possible states due to information operations and connected with them by cause-and-effect relationships action execution operations states

Then, to estimate each chain $C_n$ corresponding probabilistic measure, $\omega(C_n)$ was constructed. This measure is build in the space of all possible chains of possible actions modes sequences realizations.

For example, each chain of information - effects execution operations can be measured as:

$$\omega(C_n, S) = <P(C_n), \Delta\left(a^{jpu}, \mathrm{S}\right), n \in N>, \quad (1)$$

where $P(C_n) = P({a_n}^{j*}, S) \ldots P({a_n}^{jpu}, S)$ , ${a_n}^{jpu}$ is the probability chain $C_n$ of actions' manifestation. $P({a_n}^{j*}, S)$ is the probability of corresponding information actions realization. $\Delta\left(a^{jpu}, \mathrm{S}\right)$ measures the quality of information operations realizations $a^u$ in possible conditions (monitored by information operations and further used by them) considering all possible effects execution actions realizations $a^{jpu*}$ in each of that conditions that result from $a^u$ (possible chains of purposeful changes). Each chain of such purposeful changes quality is estimated by its final $\Delta\left(a^{jpu}, \mathrm{S}\right)$ and the probability $\mathrm{P}(a^{jpu}, \mathrm{S})$ of the chain realization. The quality of each of the mentioned information actions can be estimated as a results of possible corresponding $a^{jpu}, \mathrm{S}$ after those actions. To estimate each chain $C_n$ corresponding measure, $\omega(C_n)$ was constructed. For all possible $n \in N$ the measure $\Omega(S, It)$ was constructed, in which $It-$ is IT used for the the system's $S$ possible changes in various conditions (measured by information operations and used by information operations to alter system' functioning) as a result of information application for action in systems. Measuring $\Omega(S, It)$ characteristics (e.g. quantiles, moments and mixtures of characteristics) may serve as a system's potential vector $\Psi(S, It)$ or scalar $\psi(S, It)$ indicator. For example, if the mean of $\Omega(S, It)$ is used:

$$\psi(S, It) = \sum_{n=1}^{N} P(C_n) \cdot \Delta\left(a^{jpu}, \mathrm{S}\right). \quad (2)$$

Then a researcher can use measures (1,2) to estimate indicators of other properties, which characterize various aspects of the quality of the system change regarding IT use. To estimate indicators of IT performance or digitalization's effects under conditions of change and interaction, authors proposed [44] the difference between the values of the system's capability indicators for the use of new (e.g. digital) IT and primary (e.g. traditional) IT. Thus, new IT $It_a$ indicator $\Phi(It_a, It_0)$ compared with primary IT $It_0$ can be estimated as a difference:

$$\begin{aligned} \Phi_1(It_a, It_0) &:= \psi_1(It_a) - \psi_1(It_0), \\ \text{or, } \Phi_2(It_a, It_0) &:= \psi_2(It_a) - \psi_2(It_0). \end{aligned} \quad (3)$$

in which $\psi_i(I_j)$ is the scalar indicator $i$ of the system's capability under condition IT $j$ used.

### B. Other Schemas of Information Actions use in Systems

Based on schema and models developed other Schemas and corresponding models can be built.

In Fig. 6 schema of information application for distributed actions in systems shown. Its difference with schema in Fig. 4 is there are two (performed in parallel) effects execution actions. Actions results are synchronized and information about results sent to information action, which monitors events at the system. This information action is different in that it is able to produce coordinated prescriptions for both effects execution actions.

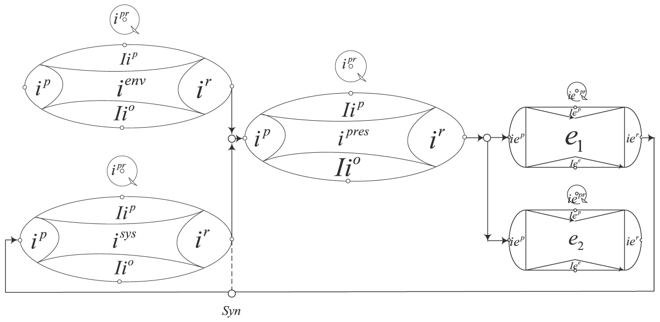


Fig. 6. Schema of information application for distributed actions in systems

In Fig. 7 schema of information application for distributed actions in systems shown. Multiple environments characterize it. Its difference with schema in Fig. 6 is in that, there are two (performed in parallel) information actions to monitor two environments with different features. For example, one of the environments can be the friendly environment and another one - the hostile environment. The results of the two monitoring information actions corresponding to each environment are synchronized and information about two environments functioning results sent to information operation, which produce coordinated prescriptions for both environments states and corresponding prescriptions for effects execution actions as a reaction on (synchronized) states of the both of environments.

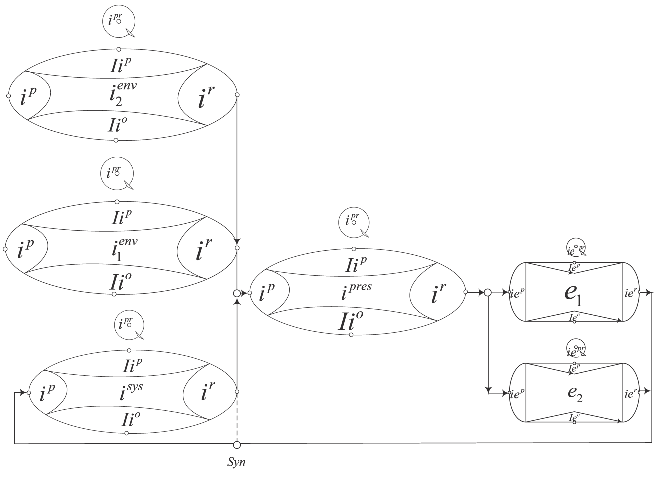


Fig. 7. Schema of information application for distributed actions in systems with sustainable environment

In Fig. 8 schema of information application for distributed actions in systems with multiple environments, among which one is considered as sustainable environment shown. Sustainable part of environment is considered as that part of environment, which states are partially defined by some effect execution actions directed by humans. Generally, such actions are intended to prevent sustainable environment from degradation, losses or other negative effects and to save it states within required borders. Its difference with schema in Fig. 7 is in that, one of environments connected to one or to a few (like at Fig. 7) material execution actions. The results of effects execution actions on the environment can be limitations of negative effects, like carbon dioxide or methane emissions limitation, or circular economy effects realization. Still, the two monitoring information actions corresponding to each of environments are synchronized and information about two environments functioning results sent to next information operation, which intended to produce coordinated prescriptions for both environments, taking in account demands for sustainability and corresponding to them prescriptions for two coordinated (in space and time) effects execution actions as a reaction on (synchronized) states of the both of environments - hostile and friendly, sustainable environment.

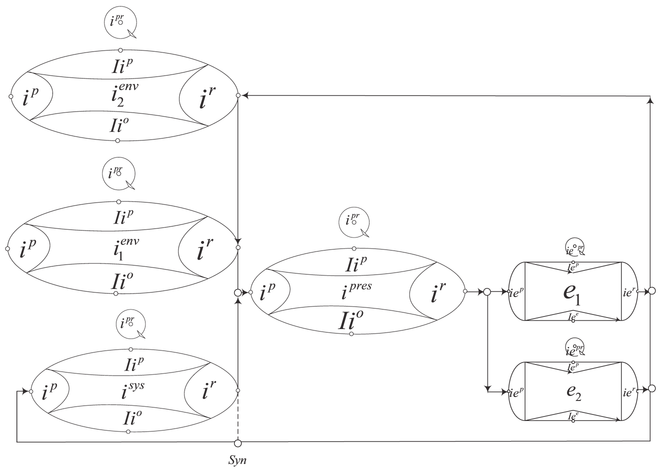


Fig. 8. Schema of information application for distributed actions in systems with sustainable environment

## VI. Discussion

Diagrammatic models presented were used for further formalization. Such formalization is possible through creation, based on the diagrammatic models suggested, the graph-theoretic models, labeled graph-theoretic, and then functional models. Such formalization opens the road to the formal description of a series of effect execution actions, possible changes, and possible chains of changes due to different information processing results. Such chains are modeled as information actions - realizations of effect execution actions chains. Schemata suggested were used to estimate the system's potential indicators regarding information application for actions in systems. Suggested schemata further allow mathematical models for quantitative estimation of system capability and other properties concerning information application for actions in systems. Researchers can implement such estimation depending on the parameters and variables of the information operations. Current limitations of the concept and models suggested are a small number of schemata recommended for limited cases of information application in systems and their discrete nature reflected by graph-theoretical models used. Further research should be done to overcome limitations of suggested models, to model a broader range of various kinds of information applications and different system functioning using candidate theories results found in the literature review conducted. Researchers should create new types of models and technologies based on models of the information application for actions in systems. Research can be conducted on possible applications of the mashing learning technologies for information application based on big data about actions and applications to predict system response to information actions outside the system under study.

## VII. CONCLUSION

The concept of information application for actions in systems is suggested in the article. Then, the authors suggested corresponding diagrammatic models of information application. Deciding problems of information technologies, information actions characteristics, and systems behavior characteristics justification regarding information application for actions in systems are now possible.

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