MATEC Web of Conferences **245**, 03021 (2018) https://doi.org/10.1051/matecconf/201824503021
EECE-2018

On the issue of personnel management in high-latitude construction

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Abstract. Mathematical modeling of the subject in the security system of construction in the Arctic region and the system of events characterizing the event structure of the subject are proposed. The security structure of the subject is given as an example. The practical result of the work is the possibility of a mathematical interpretation of the system of effective management of training and assessment of the combat capability of individuals and groups, taking into account their physiological, psychological state and habitat in the Arctic region.

In developing the Arctic region the most important aspect is people's physical condition, training and skills. In severe climatic and spatial conditions of the Arctic behavioral functions of a subject have a direct impact on the risks of its security. The population is formed and changed under the influence of internal (nature of production, culture and life, physical abilities, skills) and external (environment, legal and moral norms of society, etc.) factors. The features of the population risk safety calculation consist in strict control of physical and chemical laws by means of mathematical formulas, while behavioral characteristics of the people are not considered. It has so happened historically, that consideration of physical and chemical processes has excluded a human being. However, the main function of construction projects is creation of conditions for stay and work of people, taking into account mutual influence of a building or structure and its occupants (as the presence of people outside the building in the Arctic is disastrous) [1,15,16]. Therefore, the security risks of the population of the Arctic region should be considered inseparable, including the object and the subject.

The authors have conducted a study of the safety of the object of high-latitude construction from the point of view of the event structure of the subject [2] for the purpose of automating the management of personnel of high-latitude construction.

1 Methods of research

We are going to suggest the classification of the population of the Arctic region in terms of ability to resist threats and dangerous effects. For this we use the experience of oil and gas workers on offshore facilities in the sea, as the situation is similar in the Arctic.

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The philosophy of the staff of offshore facilities is focused on the idea that part of the employees, who are responsible for saving lives, property and environment protection, develop the necessary skills of emergency response, and the others take responsibility for their own evacuation and survival (these principles are typical for the indigenous population).

Thus, the population as for the safety risks consists of different groups and can be subdivided into:

Low - mobility groups – children, sick and elderly people, that is, those who cannot evacuate themselves and survive.

Groups without specific duties (guest groups) – people with minimum education standards as for safety, knowledge of the object, sources of potential hazards, evacuation routes and survival techniques. The main task of the personnel without specific responsibilities is connected with their own personal safety, evacuation and survival.

Professional groups - people engaged in specific activities. They must have knowledge of production or another area, methods of evacuation, preparation for evacuation of the facility and, if necessary, application of methods and technical means of self-salvation, to be able to provide a meeting of experts, to organize measures to minimize the consequences of emergencies, to have skills of elimination of accidents, fire, disaster in the emergency-rescue units.

Special groups – are the staff with the level of competence required in an emergency response situation.

Based on the definitions of the Arctic population in the calculation of safety risks one should consider the physical condition of the subject and the level of its competence. To do this, we introduce the general concept of safety eventology of the subject [3, 5,7].

In eventology the safety of the subject — is a manifestation of the event doublet by the subject; the subject eventology model $\mu \in$ is determined by the event doublet,

$$\ddot{\mu}=\{\mu\downarrow, \mu\uparrow\},$$

consisting of events of extrovert perception $\mu\downarrow$ and events of extravert activities of $\mu\uparrow$; the event of introvert perception $\mu^c\downarrow$ and the event of introvert activity $\mu^c\uparrow$ serve as theoretical plural additions to them.

The status of the low- mobility subject $\mu \in \mathfrak{M}$ — is a lack of knowledge and skills, inability of understanding the reality, limitation or inability of independent movement; this status is characterized by extrovert perception and extrovert activity — a terraced event $\mu\downarrow\cap\mu\uparrow$.

The condition of the subject without specific duties $\mu \in$ — is minimum knowledge of the object, safety, sources of potential hazards, evacuation routes and means of survival; this status is characterized by extrovert perception and introvert activity — terraced event $\mu\downarrow\cap\mu^c\uparrow$.

The status of the professional subject $\mu \in \mathfrak{M}$ is characterized by specific knowledge of production or another area, methods of evacuation, preparation for evacuation of the facility and, if necessary, application of methods and technical means of self-salvation. They are able to provide a meeting of experts, to organize measures to minimize the consequences of emergency situation, master the skills of elimination of accidents, fire, and disaster in the emergency-rescue units; in eventology the state is characterized by introvert perception and extrovert activity — terraced event: $\mu\downarrow\cap\mu^c\uparrow$.

The state of the special subject $\mu \in \mathfrak{M}$ is the one with the level of competence required in an emergency response situation; in eventology is characterized by introvert perception and introvert activity — terraced $\mu_{\downarrow}^{c} \cap {}_{\downarrow}^{c}$.

To summarize, we can say that the eventology system $S\ddot{\mu} = \ddot{\mu} + \text{terr}\,(\ddot{\mu})$, serves as the subject safety eventology model $\mu \in$ defined by the basis – event doublet $\ddot{\mu}$ = {extrovert perception, extrovert activity}, and a shell - terraced split

$$\text{terr}\,(\ddot{\mu}) = \{\text{ter}\,(Y//\ddot{\mu}) : Y \subseteq \ddot{\mu}\} = \{\text{ter}\,(\ddot{\mu}//\ddot{\mu}), \text{ter}\,(\{\mu\downarrow\}//\ddot{\mu}), \text{ter}(\{\mu\uparrow\}//\ddot{\mu}), \text{ter}\,(\emptyset//\ddot{\mu})\} = \{\mu\downarrow \cap \mu\uparrow, \mu\downarrow \cap \mu_{\uparrow}^{c}, \mu_{\downarrow}^{c} \cap \mu\uparrow, \mu_{\downarrow}^{c} \cap \mu_{\uparrow}^{c}\} =$$

= {low –mobility, *without specific duties*, *professional*, *special*}

generated by basis $\ddot{\mu}$. Probabilities of the terrace events

$$P\,(Y//\ddot{\mu}) = \mathbf{P}(\text{ter}\,(Y//\ddot{\mu}))$$

from the terrace split terr ($\ddot{\mu}$) form a probability distribution

$$\{P\,(Y//\ddot{\mu}) : Y \subseteq \ddot{\mu}\}$$

of the event system $S\ddot{\mu}$ and its basis $\ddot{\mu}$, which eventologically characterizes the safety of the subject $\mu \in \mathfrak{M}$, indicating probabilities.

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This eventology subject safety model reflects a well-known observation of the indigenous people of the North. Each entity in each moment of time is characterized by its own mixture of physiological and psychological states, which manifests itself in its event-driven interaction with the outside world in the form of eventological distribution of «pure» population groups: low-mobility groups, without specific duties, professional and special groups.

In this paper, an event hypothesis has been adopted according to which a subject "is projecting" the structure of its own event device on everything it deals with in event-driven interaction. In other words, the subject is able to perceive event-driven environment exclusively through its event-driven "points", the design of which is characterized by its own event device. In the process of this "projection" the subject transfers only the form of its own event structure, without affecting the contents of the event environment: it "clothes" event contents of its environment in its own event form.

Let us consider one of the simplest eventology models of event-driven "points" of the subject, based on this hypothesis. To understand it let us start with an example in the framework of the eventology safety system $(\hat{\ddot{\mu}}\,\mathfrak{M}, \hat{\ddot{b}}\,\text{B}, \hat{\ddot{x}}\mathcal{X})$, in which there are three event figures: a total subject $\hat{\ddot{\mu}}\,\mathfrak{M}$, a total barrier $\hat{\ddot{b}}\,\text{B}$ and a total object $\hat{\ddot{x}}\mathcal{X}$. Any object or barrier event makes sense in the safety system only when interacting with the subjects $\mu \in \mathfrak{M}$ that form an integral event helper — aggregate subject $\hat{\ddot{\mu}}\,\mathfrak{M}$. However, in this example we will be interested in event - driven interaction of only one subject $\mu \in \mathfrak{M}$ with one barrier

$b \in \mathcal{B}$, forcing the subject to "project" its own event structure on the barrier. And then - the interaction of the same subject $\mu \in \mathfrak{M}$ with the object $x \in \mathfrak{X}$, forcing it to "project" their own event structure on the object.

Let us denote

$$S\ddot{\mu}=\{ \mu\downarrow, \mu\uparrow\} + ter(\{ \mu\downarrow, \mu\uparrow\}) \quad (1)$$

— a system of events characterizing the subject event structure $\mu \in \mathfrak{M}$. This system consists of the basis —the event doublet

$$\ddot{\mu}=\{ \mu\downarrow, \mu\uparrow\},$$

and the shell —the terrace split

$$terr\ (\ddot{\mu}) = \{ter(Y//\ddot{\mu}): Y \subseteq \ddot{\mu}\},$$

generated by doublet $\ddot{\mu} \subset A$

Our goal is first to determine the event structure of the barrier [3] $b \in \mathcal{B}$, relying only on the event system $S\ddot{\mu}$ and barrier event $b \subseteq \Omega$ as simple as possible so that it can be characterized by the event system of the same type

$$S\ddot{b}=\ddot{b}+terr\ (\ddot{b}) \quad (2)$$

with basis

$$\ddot{b}=\{ b\downarrow, b\uparrow\}$$

and the shell —terrace split

$$terr\ (\ddot{b}) = \{ter(Y//\ddot{b}): Y \subseteq \ddot{b}\},$$

generated by the doublet $\ddot{b} \subset A$.

Technically the only easy way to determine system $S\ddot{b}$ satisfying the formulated conditions, is given by the formulas [6].

$$\ddot{b}=\ddot{b}(\mu) = \{ b\downarrow(\mu), b\uparrow(\mu)\} = \{ b\cap\mu\downarrow, b\cap\mu\uparrow\},$$
$$terr\ (\ddot{b}(\mu))=\{b\cap ter(Y//\ddot{\mu}):Y\subseteq\ddot{\mu}\}.$$

There is nothing for it but to give this lapidary technical solution a substantial interpretation. Let us look for the interpretation of safety with an example, known as fire barrier event

$$b = \{\omega\epsilon\Omega\text{: "No smoking" sign}\} \subset \Omega. \quad (3)$$

For this barrier we have the following interpretations for two basic events $b\downarrow(\mu)$ и $b\downarrow(\mu)$:

$$b\downarrow(\mu) = b \cap \mu\downarrow = \{\omega\epsilon\Omega\text{: the subject μ extrovertly responds to the sign "No smoking"}\} \quad (4)$$

$$b\uparrow(\mu) = b \cap \mu\uparrow = \{\omega\epsilon\Omega\text{: the subject μ extrovertly responds the sign "No smoking"}\} \quad (5)$$

$$\mathrm{terr}(\ddot{b}(\mu)):$$

and four terrace events from the split

b ∩ ter ($\ddot{\mu}$ // $\ddot{\mu}$) = b ∩ μ ↓ ∩ μ ↑ = {ω ϵ *Ω*: the subject responds in a choleric way to the sign "No smoking" (2)

b ∩ ter (μ↓} // $\ddot{\mu}$) = b ∩ μ ↓ ∩ $(\mu\uparrow)^c$ = {ω ϵ *Ω*: the subject responds in a melancholic way to the sign "No smoking"} (3)

b ∩ ter ({μ↓} // $\ddot{\mu}$) = b ∩ $(\mu\downarrow)^c$ ∩ μ ↑ = {ω ϵ *Ω*: the subject responds in a sanguine way to the sign "No smoking"} (4)

b ∩ ter (Ø // $\ddot{\mu}$) = b ∩ $(\mu\downarrow)^c$ ∩ $(\mu\uparrow)^c$ = {ω ϵ *Ω*: the subject responds in a phlegmatic way to the sign "No smoking"} (6)

Thus, the system

$$S_{\ddot{b}(\mu)} = \ddot{b}(\mu) + \mathrm{terr}\ (\ddot{b}(\mu)) \quad (7)$$

determines the barrier event structure $b \in \mathcal{B}$ in the form analogous to the subject event structure $\mu \in \mathfrak{M}$. This system is what the subject $\mu \in \mathfrak{M}$ sees in event communication with the barrier $b \in \mathcal{B}$ through its event "points".

The total subject $\mu\mathfrak{M}$ is characterized by the system

$$S_{\hat{\ddot{\mu}}\mathfrak{M}} = \hat{\ddot{\mu}}_{\mathfrak{M}} + \mathrm{terr}\ (\hat{\ddot{\mu}}_{\mathfrak{M}}) \quad (8)$$

with the basis

$$\hat{\ddot{\mu}}_{\mathfrak{M}} = \{\hat{\mu}\downarrow_{\mathfrak{M}},\ \hat{\mu}\uparrow_{\mathfrak{M}}\},$$

which consists of two events of average probability [5]

$$\hat{\mu}\downarrow\mathfrak{M}\ \text{и}\ \hat{\mu}\uparrow\mathfrak{M} \quad (9)$$

for the multitude of events

$$\{\mu\downarrow:\ \mu \in \mathfrak{M}\}\ \text{и}\ \{\mu\uparrow:\ \mu \in \mathfrak{M}\}$$

correspondingly.

The view of one barrier $b \in \mathcal{B}$ through the event "points" of the total subject $\mu\ \mathfrak{M}$, is characterized by the system

$$S_{\hat{\ddot{b}}(\mathfrak{M})} = \hat{\ddot{b}}(\mathfrak{M}) + \mathrm{terr}\ (\hat{\ddot{b}}(\mathfrak{M}))$$

with the basis

$$\hat{\ddot{b}}(\mathfrak{M}) = \{\ \hat{b}\downarrow_{(\mathfrak{M})},\ \hat{b}\uparrow_{\mathfrak{M}}\}$$

which consists of two events of average probability

$\hat{b}\downarrow(\mathfrak{M})$ и $\hat{b}\uparrow\mathfrak{M}$ (10)

for the multitude of events

$\{b\downarrow(\mu): \mu \in \mathfrak{M}\}$ и $\{b\uparrow(\mu): \mu \in \mathfrak{M}\}$

correspondingly.

The view of the total barrier $b\mathrm{B}$ through the event 'points" of the total subject $\mu\mathfrak{M}$, is characterized by the system

$$S\ddot{\hat{b}}(\mathfrak{M}) = \ddot{\hat{b}}\mathrm{B}(\mathfrak{M}) + \mathrm{terr}\,(\ddot{\hat{b}}\mathrm{B}(\mathfrak{M})) \quad (11)$$

with the basis

$\ddot{\hat{b}}\mathrm{B}(\mathfrak{M}) = \{\hat{b}\downarrow\mathrm{B}(\mathfrak{M}), \hat{b}\uparrow\mathrm{B}(\mathfrak{M})\}$,

consisting of two events of average probability

$\hat{b}\downarrow\mathrm{B}(\mathfrak{M})$ и $\hat{b}\uparrow\mathrm{B}(\mathfrak{M})$ (12)

for the multitude of events

$\{\hat{b}\downarrow\mathrm{B}(\mathfrak{M}): b \in \mathrm{B}\}$ и $\{\hat{b}\uparrow\mathrm{B}(\mathfrak{M}): b \in \mathrm{B}\}$,

which themselves consist of events of average probability

$\hat{b}\downarrow(\mathfrak{M})$ и $\hat{b}\uparrow(\mathfrak{M})$ (13)

for the multitude of events

$\{b\downarrow(\mu): \mu \in \mathfrak{M}\}$ и $\{b\uparrow(\mu): \mu \in \mathfrak{M}\}$

correspondingly.

The total subject $\mu\ \mathfrak{M}$ sees an analogous event structure through its event "points", looking at the total object object $\mathrm{X}\mathrm{X}$, which eventually is characterized by the system (Fig.5).

$$S\ddot{\hat{x}}\mathrm{X}(\mathfrak{M}) = \ddot{\hat{x}}\mathrm{X}(\mathfrak{M}) + \mathrm{terr}\,(\ddot{\hat{x}}\mathrm{X}(\mathfrak{M})) \quad (14)$$

with the basis

$\ddot{\hat{x}}\mathrm{X}(\mathfrak{M}) = \{\hat{x}\downarrow\mathrm{X}(\mathfrak{M}), \hat{x}\uparrow\mathrm{X}(\mathfrak{M})\}$,

consisting of two events of average probability

$\hat{x}\downarrow\mathrm{X}(\mathfrak{M})$ и $\hat{x}\uparrow\mathrm{X}(\mathfrak{M})$ (15)

for the multitude of events

$\{\hat{x}\downarrow(\mathfrak{M}): x \in \mathrm{X}\}$ и $\hat{x}\uparrow(\mathfrak{M}): x \in \mathrm{X}\}$,

which themselves are made up of events of average probability

$$\hat{x} \downarrow (\mathfrak{M}) \text{ и } \hat{x} \uparrow (\mathfrak{M}) \quad (16)$$

for the multitude of events

$$\{x \downarrow (\mu) \colon \mu \in \mathfrak{M}\} \text{ и } \{x \uparrow (\mu) \colon \mu \in \mathfrak{M}\}$$

correspondingly.

Thus, it is possible to regulate the behavioral properties of the subject by changing the eventual environment, first of all by accumulating knowledge, skills and abilities of a safe existence of the subject in the Arctic region. For this you should take into account the totality of individual personality characteristics.

The proposed mathematical apparatus allows, regardless of the habitat [5, 9, 10, 11], to create interactive systems [6, 7] for the effective management of training and assessment of the combat capability of individuals and teams engaged in the construction of high-latitude objects. Creation of the software based on the described methodology will allow to implement new approaches and principles of design and construction in high latitudes.

2 Conclusions

1. Safety risks of high-latitude construction have a significant social, economic and moral importance.

2. Behavioral features of the subject can be adjusted by changing the event-driven environment, primarily by accumulating knowledge, abilities and skills of safe existence of the subject in the Arctic region, but one should consider the totality of individual event characteristics of the personality.

3. The practical result of the subject safety eventology is the possibility of a mathematical interpretation of the system of effective management of preparation and assessment of the combat capability of individuals and teams, taking into account their physiological, psychological state, environment in the Arctic region.

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