Taxonomies and their role in the aviation Safety Management Systems

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Abstract
The paper focuses on the taxonomies widely applied in the aviation industry. Beside the general view on the subject, article brings a description and mutual aspects identification of the presented taxonomies. Purpose, adequate comprehension and taxonomy application, together with the identification of the subjects to whom the taxonomy are dedicated were considered as the essential facts in taxonomy description. The human factor was recognised as a critical element in aviation and in that matter, several taxonomies specialised exclusively on that issue were mentioned. The new trends in the taxonomy development, their implementation in the particular systems together with benefits they could bring to the particular processes represent the important aspects of modern approach to the issue. The paper places emphasis on the common taxonomy, development supported by ICAO, and other hazard taxonomies.

Keywords: Taxonomy, safety management system, events, hazards, occurrences
1. INTRODUCTION

As a complex and dynamic industry, aviation in all its aspects faces different safety issues. Their recognition, adequate solving or prevention represent the number one objective, allowing proper and safe system functioning. In today’s world, especially in the high-risk industry branches, approach to safety considerably changed. The modern view on the issue involves systematic approach to the problem, its proper management and risk mitigation. Therefore, existence of the efficient safety management system (SMS) is a must.

In that matter, aviation is not an exception. Establishment and functioning of the SMS within aviation organisation is recommended by International Civil Aviation Organisation (ICAO). By issuing a document regarding SMS, ICAO is trying to help in SMS implementation and comprehension of its advantages and safety or economic benefits that such system could bring (ICAO SMM Doc.9859, 2013). That is primarily possible thanks to the way the SMS treats safety and regulates concerned personnel’ attitude towards it.

Such system is oriented on on-time risk identification, safety assurance and safety promotion. Besides that, efficient SMS should include safety culture, a concept allowing personnel to report their errors without any consequences, except those errors made wilfully or due to negligence (Stolzer, 2011). This concept as a primer goal, tries to encourage personnel in occurrences reporting, which is besides mandatory reporting a vital element in improvement of organisation safety management and risk mitigation efficiency.

At this point, necessity for adequate reporting is clearly visible, therefore, organisations enabling reporting and evaluating collected information should establish comprehensive and efficient system, which will provide valuable information concerning particular event, occurrence, etc. This process requires a list of well-described and organised events, representing a possible description of the reported situation. An instrument used for this purpose is called taxonomy.

Taxonomy is a tool representing a structured selection of the different phrases or terms. Each of these should be well and undoubtedly described and arranged. Important aspect is a proper classification and relationships between stated terms. In some taxonomies, these are divided into several levels, where levels differ from each other in depth of the term description.

Taxonomies are developed according to the needs of the system into which are supposed to be implemented. Naturally, taxonomies are not meant to be used as a fixed list, but modified in a way that is most convenient for the system in the given circumstances. Due to their characteristics, taxonomies are widely applied in different branches like biology, technical sciences, medicine etc.

2. TAXONOMIES IN USE

Several taxonomies found their application in the aviation industry. The typical representatives of the events taxonomies are ICAO ADREP and HEIDI. These are complex and detailed taxonomies used by industry experts in the process of event description and categorization. Standardization Workgroup of the Safety Management International Group (SMICG) introduced another one, called SMICG hazard taxonomy, which was further developed by Civil Aviation Safety Team/ICAO Common taxonomy Team (SMICG, 2013).

Another group of taxonomies could be the one consisting of those primary oriented on the human factor and its relations to specified events and errors. Such taxonomies are HFACS, CHIRP, or TEM taxonomy.
ICAO ADREP

Accident/Incident Data Reporting Program (ICAO, ADREP 2000 Taxonomy) taxonomy, designed by ICAO represents an instrument used for safety related events description and classification. ADREP taxonomy is a detailed and complex structure of phrases or terms (or attributes) closely describing possible situation or subjects involved.

ADREP consists of several taxonomies such as: Aircraft Categories, Entities and attributes, Aviation Operation, Descriptive factors, Events, Events phases, Occurrence category, Occurrence classes, Organisations/Persons, etc.

From the event categorisation point of view, the interesting one is the list named ADREP Events. ADREP Events taxonomy brings a detailed list of events divided into several categories according to the concerned organisation. There are seven basic categories of ADREP Events containing “aggregated” events (incidents, accidents) which are further divided into other category levels that describe particular event in more detail. These basic categories are:

- Aircraft/system/component related events
- Operations of the aircraft related event
- Consequential events
- Air Navigation Services related events
- Aerodrome and ground aids related events
- Civil Aviation Authority/administration related event
- Events related to the non-compliance with regulations

In Europe, system used for mandatory incident reporting is known as ECCAIRS (European Coordination Centre for Aviation Incident Reporting System). ADREP represents the taxonomy on which the system ECCAIRS is based.

HEIDI

HEIDI or Harmonisation of European Incident Definitions Initiatives for ATM is a taxonomy designed by European Organisation for the Safety of Air Navigation (EUROCONTROL). The taxonomy represents structured list of terms chosen to be suitable and adequate for use within all area of its application. HEIDI tool is publicly available document containing seven sheets:

- Background
- Event Types
- Descriptive Factors
- Explanatory Factors
- Classification Scheme
- Safety Recommendations
- Glossary

HEIDI taxonomy is in line with EUROCONTROL Safety Regulatory Requirements or more precisely ESARR 2 – Reporting and Assessment of Safety Occurrences in ATM. HEIDI taxonomy is recognised as a useful supporting tool enabling better and more harmonised approach to reporting process, which is not a case with alone ESARR 2 as such.
SMICG/CICTT Hazard Taxonomy

The Safety Management International Group (SMICG) is an international organisation actively encouraging the development of the hazard taxonomy with the potential to be used throughout the aviation industry. Taxonomy distinguishes four types of mutually related hazards, the technical, human, organisational and environmental hazards (SMICG, 2013). Each of these is applicable to the different aviation entities interested or involved in the safety issues and risk mitigation process. Here, it is primarily meant ATM, Maintenance, Airports, etc.

The important aspects in this case are internal relations between stated hazard groups and their dependence on each other. This involves necessity for the approach to the problem, which does not exclude, in contrary it strongly supports finding a contributors or root cause that lead to the failure or accident realisation. This process combines or more precisely searches for potential hazards from each of the defined categories in order to reach correct comprehension of the analysed event. Detected hazard defined in any category does not exclude hazards from the other categories, in other words it tries to find potential causes of event by deeper analysis and determination of the events chain (SMICG, 2013).

CHIRP

Confidential Human Factors Incident Reporting Programme (CHIRP) is an incident reporting system active in the Great Britain. It was designed as a system enabling voluntary event reporting to the interested entities in the aviation industry (Beaubien, Baker, 2002). Even though its name states that focus is placed on the Human Factor issues, available sources give different opinions on the subject (Beaubien, Baker, 2002). Generally speaking, there are not sufficient information regarding the internal programme functioning and the process of reports categorisation and analysing. As well as other systems, CHIRP has its cons too, of which the biggest one could be inability for causal chain reporting.

ASRS Anomaly Code

Together with the HFACS and TEM taxonomy, ASRS Anomaly Code taxonomy belongs to the group of those based on the Human Factor related issues. Aviation Safety Reporting System (ASRS) Anomaly Code is an instrument used on reports collected within ASRS. Anomaly Code was used during report analysis where according to the occurrence details, reports were marked with appropriate code related to the different issues (Beaubien, Baker, 2002). ASRS as such had its flaws, primarily due to unsatisfactory terms determination and distinction. Another reason why it did not find its way to the application in the standard FAA Aviation Safety Action Program (ASAP) reporting form was its inappropriateness for direct use by the crew.

TEM Taxonomy

Threats and Errors Management (TEM) taxonomy was developed by the group of experts from the industry, primarily safety experts and crewmembers, all with the many years of experiences. The main idea was to create a new taxonomy, which would be, in terms of used terminology, more “user friendly” or easily comprehensible by person using it. In contrary to other known taxonomies this one is suitable and directly usable by captains for events reporting needs.

Similarly to the previous two, TEM taxonomy is also the one oriented on the human factor issues. The whole concept of TEM is based on finding the possible threats that could have negative impact on the human factor in the respective system. It assumes that active threats could lead to the increase of personnel errors made during activities performance. The concept is based on on-time threats detection,
proper reaction training for the crew and adequate measures application leading to the decrease of the experienced impacts (Stolzer, 2011; ICAO TEM, 2005).

In comparison to ADREP, TEM taxonomy is simpler and more concise. The reason for that lays in the necessity to be as understandable and usable as possible. It should help the crew to perform reporting in a more effective way, thus providing higher quality information used in the incidents or accidents analysis.

HFACS

The Human Factor Analysis and Classification System (HFACS) represents a system developed with the primer goal to support accident analysing process by finding a role of the human factor element and causes directly related to it, which later on could have an impact on the accident realisation (Wiegmann, Shappell, 2001). HFACS includes four failure levels. Each of these four is further divided into few lower levels or categories/sub-categories. One of these is Unsafe Acts consisting of Errors and Violations categories further divided into their own sub-categories. Besides theses ones, there are also Organisational Influences, Unsafe Supervisions and Precondition for Unsafe Acts failure levels. Similarly to the ICAO ADREP, CHIRP or ASRS Anomaly Code, HFACS due to its structure and characteristics is not absolutely suitable and convenient for initial reporting.

3. TAXONOMY DESIGN AND COMPARISON

As it was presented in the previous chapters, taxonomies are designed according to the respective system requirements. Therefore, there is not a general or standard procedure, which must be followed in taxonomy design. As mentioned in the chapter concerning TEM taxonomy, they are primarily developed according to the gained experiences. The experts engaged on the taxonomy development are those actively involved in the reporting or analysing processes.

The main reason for such approach in taxonomy design is a desire for achieving a higher level of the taxonomy quality, which will enable effective provision of relevant and valuable data concerning reported events. Logically, this state could be reached in case that reporting system and appropriate training are set in a way convenient for personnel actively involved in the processes.

In that matter, interesting research subject were relationships and mutual characteristics between taxonomies. According to the available facts, the biggest difference between those mention is their ability and characteristic enabling active use by different persons performing different activities. Typical example is ADREP taxonomy, which is due to complexity of the structure and the way of the events categorisation unsuitable for initial reporting. The same applies to the ASRS Anomaly Code. On other side, efforts are made in development of the taxonomies that could be convenient for those submitting event reports, e.g. crewmembers.

Another aspect is a purpose or subject to whom the taxonomies are dedicated. Taxonomy HEIDI was designed for the ATM expert use. Nowadays, there is an effort leading to the final coordination and its implementation into ADREP taxonomy.

4. DEVELOPMENT OF THE COMMON TAXONOMIES

In order to reach a global approach and establish mutual understanding of the safety issues same efforts were made and are still in place. Activities in this direction were primarily performed by Commercial Aviation Safety Team/ICAO Common Taxonomy Team (CICTT). From the early 2000’, the goal was to establish the new globally applicable common taxonomies that would enable a unification of the view on
the safety related issues. In practical terms, it represents the steps leading to the creation of the mutual taxonomy that would be used and comprehended equally and in a similar way. This way, no matter who or where performs an analysis, reached results could become a globally valuable and their sharing among interested or involved subject could be significantly improved.

Some results in this direction were already achieved. In the last decade ADREP taxonomy was subject of change and that practice did not change to this date. CICTT developed several taxonomies of which the one called ‘Occurrence Category’ was adopted and added to the ADREP taxonomy. Other CICTT taxonomies are expected to be added to ADREP in the future (Stephens, 2008). Such process requires time and resources, firstly due to a complexity of the modification process and secondly due to adoption period required for proper system functioning. Global approach to the safety issues requires enhanced connectivity, coordination and collaboration between available and currently used systems. From the practical point of view, the current direction of the common taxonomy development clearly shows an effort for reaching a desired interconnection and establishment of the common strategy to the issue solving process.

5. CONCLUSION

Generally speaking, taxonomies with all their features represent unavoidable instrument in the process of categorization and description of i.e. events, states, etc., within respective systems. Their main purpose is to enable the analyst or person how is submitting a report to perform activities in a way that could result in a provision and evaluation of the valuable and meaningful data. Taxonomies as such, are not self-sufficient. They are supporting tool in e.g. reporting systems enabling better understanding, definition and categorisation of the reported subjects.

Aviation as an industry branch where safety is a paramount priority uses taxonomies widely. In the case of complex taxonomies, categorisation of the aviation safety related issues sometimes requires more effort and engagement of the system experts. Besides that, taxonomies are often designed in a way that prevents their wide use among all subjects involved. This is to be considered as the biggest flaw and the main reason for some taxonomy not to be used.

It is quite visible that effort in making convenient taxonomies dedicated to particular entities as well as development of universal taxonomy has been made. This is only the positive evidence that approach to the safety as a whole is constantly changing, or more precisely, developing in a way that could show the path to the required or expected results.

References


