Ontology-Based Approach for Human Competency Gap Analysis in Air Traffic Management.
A Case Study of Georgia

PhD Student: Nika Tikanashvili

Barcelona 2018
President of Latvian Transport Development and Education Association.

Professor at Transport and Telecommunication Institute, Dr.hab.sc.ing. Igor Kabashkin.
 CONTENT

✓ Idea of the research;

✓ Research methodology;

✓ Early results;

✓ Future study.
“In the ATM target concept it is recognised that humans (with appropriate skills and competences, duly authorised) will constitute the core of the future European ATM system’s operations”.

SESAR CONOPS

“Human factors research and engineering requirements must be met, to achieve reduced air traffic delays and increased safety”.

NextGen

“People create safety”.

NATS Safety
Aviation System Block Upgrades (ASBU) Enables

- Increased Air Navigation Capacity and Efficiency
- Improved environmental efficiency
- Economic Development of Air Transport
- Optimized Travel Time
- Safety
Planning and Implementation Regional Groups (PIRGs)

Regional situation analysis

Monitoring

Human Resources Training
Full life-cycle costs
Stakeholder commitments

GANP

Assessment Prioritization
Identify & mitigate gaps
Select relevant Modules
Elaborate/refine scenarios options
Perform initial CBA/feasibility analysis
Assess impact on priorities
Set strategies and objectives

PIRG

Update regional implementation plans
Update national plans

Implementation

27-Jun-18 8th International Conference on Research in Air Transportation “ICRAT-2018”
ATM SYSTEM

Air
- Human
- Machine

Ground
- Human
- Machine

System performance

Human performance
Investing in human performance

- Improving system design, development & implementation processes and outcomes
- Improving procedures and training
- Improving selection, recruitment, staffing
- Improving system safety
- Improving work organization
- Improving transition into operations and the social acceptance of changes.
Nowadays in the exploitation are 6 airports and 14 local airlines in Georgia.
Evolution of air traffic in Georgia

Georgia - Annual IFR Movements

- IFR movements - Actuals
- IFR movements - Baseline forecast
- IFR movements - High forecast
- IFR movements - Low forecast

A = Actual
F = Forecast

Overflights 77%
International Dep/Arr 23%
Domestic flights 0%
Progress per feature and phase in ATM of Georgia

- Optimised ATM Network Services:
  - Pre-SESAR: 59%
  - PCP: 43%

- Advanced Air Traffic Services:
  - Pre-SESAR: 52%

- High Performing Airport Operations:
  - Pre-SESAR: 100%

- Enabling Aviation Infrastructure:
  - Pre-SESAR: 82%
  - PCP: 13%
1. Investigation report – incident caused by technician’s error during maintenance of navigation aids, at Batumi international airport, on 29.02.2017;

2. Investigation report – the 4 level aviation incident caused by human error, unauthorized transport entry during the heavy snow on the runway of Kutaisi international airport, on 17.12.2016;

3. Investigation report – important incident caused human error, Turkish airlines and Azerbaijan airlines, aircrafts A-319-132 and B-767/300 767/300 unsafe approach in Georgian airspace, on 19.06.2013.

Source: Ministry of economy and sustainable development of Georgia
Example of accident caused by human error in ATM of Georgia

<table>
<thead>
<tr>
<th>Time</th>
<th>Aircraft</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>05:58:52</td>
<td>AHY-075</td>
<td>Tbiliso AHY 075 good morning approaching TETO() FL - 340</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>Good morning AHY 075 Tbilisi radar, radar contact, maintain FL-340</td>
</tr>
<tr>
<td></td>
<td>AHY-075</td>
<td>075</td>
</tr>
<tr>
<td>05:59:06</td>
<td>THY-384</td>
<td>Tbilisi THY-384 ready for descent</td>
</tr>
<tr>
<td>05:59:12</td>
<td>ACC</td>
<td>THY-384 descend initially FL 350 due traffic</td>
</tr>
<tr>
<td>05:59:22</td>
<td>THY-384</td>
<td>Descend initially 250 due to traffic THY 384</td>
</tr>
<tr>
<td>06:01:30</td>
<td>ACC</td>
<td>THY 384 maintain 350, I said 350 due traffic and turn left again</td>
</tr>
<tr>
<td></td>
<td>THY-384</td>
<td>Maintain 350 sorry my mistake THY 384</td>
</tr>
<tr>
<td>06:01:49</td>
<td>ACC</td>
<td>THY 384 turn left 30 degrees and climb level 350 I said</td>
</tr>
<tr>
<td></td>
<td>THY-384</td>
<td>Turn left 30 degrees and climbing level 350, my mistake sorry, I understood 250</td>
</tr>
</tbody>
</table>
Aim of the study

- Requirements of modern ATM technologies
- Competencies of personnel
- Training curricula outcome
The main objectives of the research

1. To create ontology for the formal representation of an educational course, its modules, learning outcomes and keywords.

2. To propose a methodology for the partially automated population of the ontology based on programme specifications and module templates.

3. To design, implement and evaluate an ontology alignment algorithm for ontologies of the educational courses and modules.
The main questions of the work

1. Which information about educational courses and modules should be used for comparison with necessary competences of ATM personal and how will it be stored in ontology?

2. How to automate the population of the ontology with the data from the documents?

3. What is the alignment algorithm for ontologies of educational courses and modules? Which similarity measures should it utilize?
**General model of ATM staff development**

**Inputs**
- GANP
- Individuals (ATM staff)
- Outcomes of E&T courses and modules

**Ontology model 1**
- ATM services
- Matrix of competences

**Ontology model 2**
- Competence pattern of individual
- Matrix of competences

**Ontology model 3**
- Competence pattern of individual
- Matrix of competences

**Comparison**
- Requirements for the development of individual competences
- Requirements for the development of the contents of courses and modules

**Gap analysis of competences**
- Gap analysis of E&T curricula

**Output**
- Synthesis of content for courses and modules for upgrade of competence
### Matrix of competences

<table>
<thead>
<tr>
<th>Input</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Attitudes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$K_1$</td>
<td>$S_1$</td>
<td>$A_1$</td>
</tr>
<tr>
<td>$I_1$</td>
<td>$k_{11}$</td>
<td>$s_{11}$</td>
<td>$a_{11}$</td>
</tr>
<tr>
<td></td>
<td>$k_{12}$</td>
<td>$s_{12}$</td>
<td>$a_{12}$</td>
</tr>
<tr>
<td></td>
<td>$...$</td>
<td>$...$</td>
<td>$...$</td>
</tr>
<tr>
<td></td>
<td>$k_{1K}$</td>
<td>$s_{1K}$</td>
<td>$a_{1a}$</td>
</tr>
<tr>
<td>$I_2$</td>
<td>$k_{21}$</td>
<td>$s_{21}$</td>
<td>$a_{21}$</td>
</tr>
<tr>
<td></td>
<td>$k_{22}$</td>
<td>$s_{22}$</td>
<td>$a_{22}$</td>
</tr>
<tr>
<td></td>
<td>$...$</td>
<td>$...$</td>
<td>$...$</td>
</tr>
<tr>
<td></td>
<td>$k_{2K}$</td>
<td>$s_{2K}$</td>
<td>$a_{2a}$</td>
</tr>
<tr>
<td>...</td>
<td>$...$</td>
<td>$...$</td>
<td>$...$</td>
</tr>
<tr>
<td>$I_i$</td>
<td>$k_{i1}$</td>
<td>$s_{i1}$</td>
<td>$a_{i1}$</td>
</tr>
<tr>
<td></td>
<td>$k_{i2}$</td>
<td>$s_{i2}$</td>
<td>$a_{i2}$</td>
</tr>
<tr>
<td></td>
<td>$...$</td>
<td>$...$</td>
<td>$...$</td>
</tr>
<tr>
<td></td>
<td>$k_{ik}$</td>
<td>$s_{ik}$</td>
<td>$a_{ia}$</td>
</tr>
</tbody>
</table>
Set A of axioms

\[ O = \{ C, I, R, T, V, A, \leq, \perp, \in, = \} \]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>is the set of classes used to store the sets of individuals in a domain of interest</td>
</tr>
<tr>
<td>I</td>
<td>is the set of individuals, which are particular objects in the data domain of interest</td>
</tr>
<tr>
<td>R</td>
<td>is the set of binary relations, either between two individuals (known as Object property), or between an individual and a data type (known as Data type property)</td>
</tr>
<tr>
<td>T</td>
<td>is the set of data types (for example, integers, strings)</td>
</tr>
<tr>
<td>V</td>
<td>is the set of particular values (C, I, R, T, V being pairwise disjoint)</td>
</tr>
<tr>
<td>≤</td>
<td>is a relation on ((C \times C) \cup (R \times R) \cup (T \times T)), called specialisation</td>
</tr>
<tr>
<td>⊥</td>
<td>is a relation on ((C \times C) \cup (R \times R) \cup (T \times T)), called exclusion</td>
</tr>
<tr>
<td>∈</td>
<td>is a relation over ((I \times C) \cup (V \times T)), called instantiation</td>
</tr>
<tr>
<td>=</td>
<td>is a relation over (I \times R \times (I \cup V)), called assignment</td>
</tr>
<tr>
<td>A</td>
<td>Is a set of axioms, which consist of logical statements that are always true, and the knowledge that can be derived from them. They may contain ontology restrictions (constraints) that are imposed on the values of properties. The types of constraints depend on the expressiveness of the ontology representation language.</td>
</tr>
</tbody>
</table>
Future Study

Open questions:

➢ What the procedures and requirements do we need to become educational and real airport environment harmonized in Georgia?

➢ What type of updated training methodology do we need for the industrial practices?

➢ Where is the main difference between international and national models of aviation education?
Thank you for attention

Human Performance + Safety = Good Business