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Competency-Based Training and Assessment (CBTA) Framework in Global Aviation Training

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ABSTRACT

One of the most critical aspects of workforce planning in Human Resources Management (HRM) is ensuring that employees have the necessary skills and competencies to do their jobs. The growth of low-cost and traditional carriers has increased the reach, breadth, depth, and frequency of traditional passenger-carrying services. Because of the growing demand for highly qualified specialists in intelligent human systems, airline recruiters are under pressure to develop new ways to entice and interact with potential candidates. The study's goal was to incorporate Competency-Based Training and Assessment (CBTA) into the transformation of intelligent human system integration for aviation employees in terms of planning, training, and management. The research team conducted a theoretical analysis of the CBTA framework and identified performance gaps for aviation subject matter experts. It recommended implementing the CBTA framework using Artificial Intelligence (AI) across global aviation networks. While developing the global CBTA framework, the authors examined the controlling factors and trends in the aviation sector, providing a global approach to managing Human Systems Integration (HSI) change. Marques et al. (2023) proposed that aviation schools emphasize quality over quantity, provide opportunities for continuing education, and encourage learning beyond the ab initio basic knowledge requirements (e.g., quality performance-based training pilot hours incorporating immersive technologies such as Artificial Intelligence-AI or/and Simulated Air Traffic Control Environment-SATCE). Organizational culture, resistance to technological advancement, and employment rules all impact demand. This study presents a synthesis of the Lean Six Sigma (L6) strategy and the CBTA framework as an alternative to the traditionally widely used method in many countries, which enhances change management in organizations. The findings of this research project suggest that, in addition to using the suggested Lean Six Sigma Recruitment procedure, the aviation industry should reconsider its organizational culture and implement an integrated CBTA - AI strategy.

Keywords: Competency-based training and assessment (CBTA), Aviation intelligence (AI) human systems, Human resources management (HRM), Manpower planning

INTRODUCTION

Many organizations around the world need help in successfully planning their human resources. This problem arises when organizations try to match

people with specific skills and abilities to their immediate and long-term needs and goals (Marchington, 2015). There have been numerous articles and books written on the subject of effective manpower planning, and these provide theoretical and practical guidelines for successful and efficient human resource administration (HRM). Theoretically and practically, organizations are encouraged to consider how they might and should structure their human resources to create strategic differences in their markets (Paauwe & Boon, 2018). On the other hand, many businesses get stuck in a cycle of limiting employee availability day-to-day to meet short-term resourcing needs at the operational and tactical levels, which distracts them from strategic planning and prevents them from meeting their objectives (Armstrong & Taylor, 2014). Furthermore, when viewed in a broader context, the employment process in the aviation industry has several issues, many of which have been documented and may be observed in practice (Taylor & Cotter, 2019).

Several elements might operate as strategic limits for airlines. These include organizational culture, rivalry for strategic goals, and a need for more strategic alignment. When looking to fill a position in the aviation business, one of the most significant factors that should be considered is the level of specialization required of the candidate's previous work experience and qualifications (Lewis et al., 2015). Because the qualifications necessary to work in the flight operations and flight training departments are apparent and can be demonstrated through the use of a certificate, it takes more than generic or blanket passive recruiting methods to find the right people who are competent in Aviation Intelligent Human Systems (Gnanprakash & Kulkarni, 2016).

Additionally, Paauwe (2018) proposed a model analogous to the airline HR Planning and Analysis Model, which may be seen below in Figure 1. The model that has been proposed illustrates how a corporation may use its strategic plan to work out how the firm will transition from where it is now to a set of values that will assist it in achieving its objective. As a result, deficiencies in performance (competencies) and human resources (manpower planning) are identified to reach the intended state. Plans and strategies about human resources (HR) emphasize various performance domains, including Aviation Intelligence Human Systems job design, job description, and categorization, in addition to HR information management. Figure 1 illustrates how HR operations contribute to the company's overall success in achieving its strategic objectives.

Verified CBTA-EBT/psychological applications were implemented during the change management process. The "competency" human performance trait is used to predict job success. Competence is demonstrated when a person exhibits behaviors that rely on the appropriate knowledge, abilities, and attitudes to carry out activities or tasks within predetermined boundaries. Purdue's professional flight program recognized technical and nontechnical competencies following IATA regulations. Furthermore, the Purdue study used qualitative and quantitative techniques to support the idea that incorporating a structured recruitment and selection plan into an AI-driven competency-based training assessment strategy improves organizational performance. By adding personnel capabilities that reduce performance differences, the chosen inductive research technique aims to reduce hiring

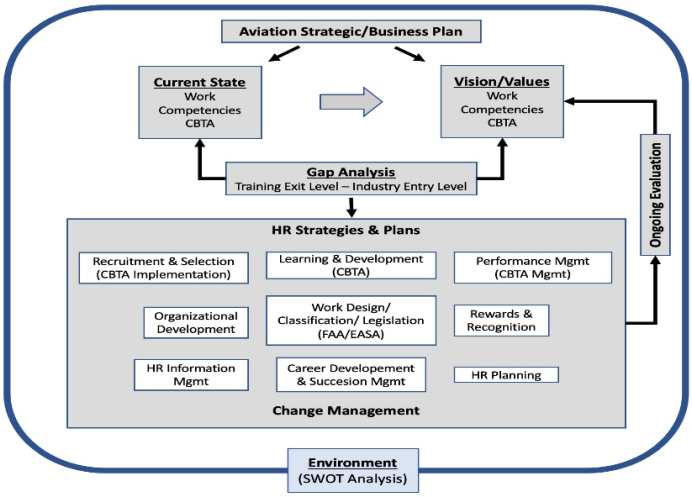

Figure 1: Aviation performance gap analysis and change management (Ziakkas, 2022).

and training wait times for pilots. The study also examines how Lean Six Sigma training and personnel planning affect airline operating costs. Airlines can save time and money on hiring new employees and employee training by eliminating unnecessary steps from the hiring process. Purdue Research's roadmap focuses on CBTA standards implementation in the global AI aviation ecosystem, AI training with a change management strategy, and AI certification (FAA, EASA).

DEVELOPING CBTA DATABASE TO SUPPORT GLOBAL AVIATION SYSTEMS DESIGN

Human Systems Integration (HSI) is becoming an integral component of complex systems to assist with design solutions. This represents a substantial possibility for the aviation sector to shorten development cycles, but it also raises questions about the dependability of Machine Learning/Deep Learning ML/DL software. In addition, the Purdue Research road map is centered on the identified obstacles:

- "*Traditional frameworks for development assurance are not suitable to machine learning.*"

Machine learning (ML) highlights several steps in the process, including data preparation, architecture, algorithm selection, hyperparameter tuning, etc. A paradigm shift is required to create learning-specific assurance processes ("learning assurance" building block, EASA, 2020, Selection in Aviation, EAAP, 2022).

Machine learning (ML) is a subset of AI that refers to learning from past experiences (input data) and predicting the future. Statistical learning methods, predictive modeling, data mining, image recognition, and natural language processing are typical applications in the selection industry (Luxton, 2016). These methods provide a computational approach to dealing

with uncertainty and can help psychologists and human resource professionals optimize selection decisions. The Purdue human systems integration team is developing a test plan with CBTA tools that could be easily incorporated into the systems engineering test plan to implement AI in aviation training globally and evaluate the results. Moreover, Tippins, Oswald, and McPhail (2021) argue that the effectiveness of ML prediction or clustering in personnel selection settings is more likely to be driven by the availability of high-quality data than by the specific ML algorithm chosen. Justified predictions are dependent on both good measurement processes and valuable data.

- "*Difficulties in maintaining an exhaustive description of the desired function.*"

Artificial Neural Networks (ANNs) are brain-inspired mathematical models important to deep learning algorithms. The selection of relevant psychometric predictors in people selection is crucial to developing parametric or nonparametric classification models.

Maroco and Bartolo-Ribeiro (2013) assessed the sensitivity, specificity, and accuracy of traditional parametric classifiers (linear discriminant analysis, logistic regression) and four nonparametric neural networks (multilayer perceptron's, radial bias function, probabilistic neural networks, and linear neural networks) developed for classification tasks in the prediction of pass versus fail pilot candidates on a flight screening program. They discovered that basic, rigid parametric classifiers might need more understanding of the range of interactions and direct effects that delay the link between data points. However, more complicated and flexible models like neural networks tend to overfit the data and demonstrate model instability when extrapolating to new situations. Maintaining a traceability relationship with higher-level needs and ensuring the completeness and accuracy of the data collection may become increasingly difficult. Moreover, the dataset's quality will be of utmost relevance, as insufficient or inaccurate data may affect the training model's behavior. The difficulty will also depend on the type of ML process: Unsupervised or reinforcement learning may result in less predictable behavior than supervised learning. The Purdue CBTA approach offers a validated global database offering accessible data accepted by ICAO and several civil aviation organizations worldwide.

- "*The lack of predictability and explicability of the machine learning application's behavior.*"

ML applications are, by definition, probabilistic. Even if a machine learning (ML) model is mathematically deterministic (for example, fixed weights in a neural network), the output for any new input will be influenced by the correlation between that input and the training data set. This can lead to unpredictable and difficult-to-understand outcomes. As a result, more research into the concept of 'AI Explainability' ('explainability' building block, EASA, 2020) is required to expand the capability of making the conditions that led to a specific output more accessible. There currently needs to be more data sets to generalize the findings to a larger population. In the initial phase, however, a controlled small sample size research study (Purdue proposed research case study) would satisfy a linear analysis for personnel

selection. Klokker et al. (1999) discovered that a trained neural network technique could contribute to the meaningful selection of pilots before beginning military flight training by rejecting applicants who are unlikely to succeed in a separate study.

To meet these areas, Purdue University's current perspective on competency-based training (Keller et al., 2020) and an examination of ongoing technology potential (e.g., AI) in aviation training recommend a simple-to-complex, comprehensive aviation training approach. The suggested shift in training philosophy by the CBTA should not be viewed as merely a replacement for an older, obsolete set of critical events. Instead, the concept is a method for improving and assessing team performance by incorporating human factors elements and clearly defined Artificial Intelligence student learning objectives.

AI in aviation capabilities and standardization is used to apply content efficiency, teaching experience, and aviation market needs as the industry transitions to CBTA; airlines and regulators will need to adopt additional competencies and support for flight schools. SATT modified the AT-38800 course (Large Aircraft Systems), as shown in Figure 2, to familiarize students with Phase I and relate it to Phases II and III.

Furthermore, Purdue's study reveals a strong correlation between lowering operating and training costs and employing the CBTA - lean approach (Ziakkas, 2022). As a result, strategic goals should be developed and implemented in the firm while maintaining lean processes and reasonable operational expenses, as demonstrated in the following common area (See Figure 3).

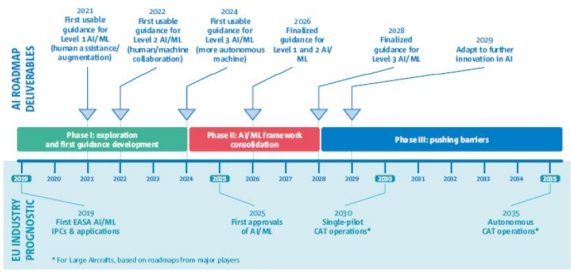

Figure 2: Artificial intelligence in aviation roadmap (EASA, 2020).

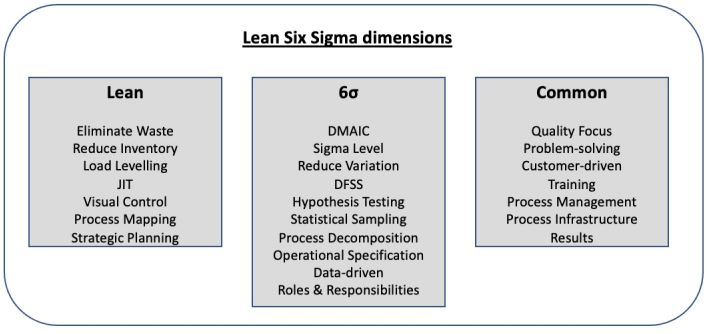

Figure 3: Purdue lean six sigma dimensions (Ziakkas, 2022).

CBTA - A SUPPORTIVE FRAMEWORK

In aviation, "competency" refers to a human performance characteristic used to predict successful job performance. The manifestation and observation of competency occur when an individual engages in behaviors that necessitate the appropriate knowledge, abilities, and attitudes to carry out activities or tasks within predetermined parameters. The study adheres to the ICAO's description of knowledge, abilities, and attitude (ICAO, 2022):

- "Knowledge is specific information that enables a learner to develop and apply the skills and attitudes required to recall facts, identify concepts, apply rules or principles, solve problems, and think creatively in the workplace.,"
- Purdue University's School of Aviation and Transportation Technology (SATT) professional flying program recognized technical and nontechnical competencies based on International Air Transport Association (IATA) guidelines. Purdue University researchers used qualitative and quantitative methods to test the hypothesis that implementing a Competency-Based Training Assessment in conjunction with a structured recruitment and selection plan improves organizational performance.

General aviation flight training has become a common entry point to an air transport pilot career in the United States. The growing demand for flight crews has necessitated recruitment from all industry sectors. Depending on the training path, the Federal Aviation Administration requires pilots to have logged between 1,000 and 1,500 hours to be eligible to fly for the airlines. While Airmen Certification Standards specify certain types of flights and other criteria to be satisfied within those hours, airline trainees are often recruited directly from a flight training or other general aviation environment. During the past five decades, training curricula have embraced crew resource management and scenario-based training as strategies to improve attitudes and target higher levels of learning starting from the initial stages of training. While these methods are separate from CBTA, they have had efficacy in achieving their goals.

Similarly, CBTA can address needed areas of achievement throughout training. Including CBTA from the outset of the flight training process benefits students, flight schools, and future employers. Students trained following CBTA will be better prepared as they progress throughout their careers and fly more sophisticated equipment. Flight schools will have a framework that can be used with FAA standards to measure student achievement. Using CBTA from the beginning of private pilot training allows for the achievement of competencies to be measured accordingly as tasks become increasingly complex. In addition, the CBTA model can assist with proactively identifying deficiencies. Future employers will reduce wasted costs and other resources resulting from student washout as their new hires have higher quality flight experiences within their mandatory flight hours and have been assessed consistently during their training.

The inductive research method is used to find ways to accelerate the process of hiring and training pilots by giving them skills that make them better

at their jobs. The study also looks at how the Lean Six Sigma planning and training process affects the operating costs of an airline (Figure 3). The research and the lean mentality are related because removing unnecessary steps from the hiring process can help airlines save money and time on hiring and training employees.

CONCLUSION

In order to help with the resolution of system designs, human systems integration (HSI) is increasingly becoming a crucial part of complex systems. This study aims to develop a plan for integrating the Competency-Based Training and Assessment (CBTA) framework into the organization, planning, and management of the change in aviation personnel's intelligence human systems. Lean manpower planning will be used in conjunction with the projected adoption of CBTA to create a uniform and reliable methodology. This method will align with the suggested workforce planning procedure, enabling interactions with candidates while minimizing the recognized workforce planning inconsistency.

As a result of the aviation industry's globalization, several airlines are forced to adopt cross-border hiring practices. As a result, recruiters must transition from being passive human resource agents to active CBTA professionals who can create a larger pool of competent candidates. There will be a larger need for airlines and regulators to adopt competencies as the industry transitions to CBTA models, as well as support for flight schools.

The Purdue Research roadmap also emphasizes AI certification (FAA, EASA), adopting an AI training curriculum employing a change management strategy, and establishing AI standardized principles in the international AI aviation ecosystem. In order to address the issue of recruiting and selecting new aviation SMEs, airliners must reconsider the organizational culture, establish an integrated CBTA strategy, and put the suggested Lean Six Sigma Recruitment process into practice. This is required to address the issue of new employee recruitment and selection.

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