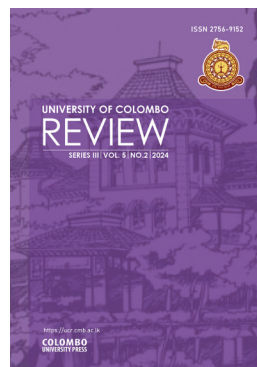


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Evaluating the Attitudes and Trust of Sri Lankan Air Traffic Controllers towards Accepting Automation in terms of Electronic Flight Strips

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ABSTRACT

The adoption of Electronic Flight Strips (EFS) is a global trend aimed at streamlining the routine tasks for Air Traffic Controllers (ATCs), yet Sri Lanka continues to use traditional paper-based systems. This study investigates the potential acceptance of EFS automation by Sri Lankan ATCs, examining factors such as perceived usefulness, perceived ease of use, trust, and attitude toward automation within the Technology Acceptance Model framework. Data from 48 Sri Lankan ATCs revealed that all factors were positively correlated with automation acceptance, with perceived ease of use emerging as the most influential construct. A classification by work unit showed Approach Controllers perceived EFS as having lower usefulness compared to Tower and Area Controllers, likely due to their unique workflow. Additionally, ATCs with prior automation experience have demonstrated stronger positive attitudes, trust, and willingness to adopt EFS, emphasizing the role of experience in fostering automation acceptance. Furthermore, age and gender showed no significant impact on acceptance levels. These findings provide critical insights for EFS system designers and management to tailor training and implementation strategies, highlighting the importance of designing intuitive interfaces, building trust in safety, and leveraging experienced ATCs to champion adoption.


KEYWORDS:

Air Traffic Control, Attitudes, Automation Acceptance, Electronic Flight Strips, Perceived Ease of Use, Perceived Usefulness, Trust

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Introduction

Electronic Flight Strips (EFS) is a system that substitutes routine tasks of loading, writing, and placing or sometimes data entering and printing of flight strips, tasks that were executed manually by ATCs and demanded a considerable portion of their time and effort from the main task of traffic controlling. However, more experienced controllers are versatile enough to multitask these functions effectively. They usually spend a considerable amount of time in developing proficiency in strip handling techniques. Consequently, the question emerges regarding the feasibility of introducing automation that supersedes their acquired skills while concurrently simplifying their daily operations. The adoption of EFS has shown continuous improvement in recent decades; however, there remains a notable resistance to its implementation (Mackay and Fayard, 1999). This resistance is partly attributed to the attitudes of conservative Air Traffic Controllers (ATCs) who are skeptical of automation (EUROCONTROL, 2000) and show varying levels of trust in such systems (Muir and Moray, 1996; Lee and See, 2003). Attempts to introduce new automation systems without considering user acceptance can cause significant challenges, wasting time, effort and money. Previous studies suggest that technology acceptance is based on individuals' own attitudes and beliefs (Gattiker, 1988). Hence, the current study seeks to assess the potential adoption of automated EFS among ATCs in Sri Lanka, who are familiar with paper strips, by evaluating their attitudes, beliefs, and trust in emerging technology.

The study is structured as follows: this section presents the background information, outlines the objective of the study and presents an extensive review of relevant literature, highlighting previous work in the field. This is followed by section 2, which outlines the methodology employed in the study. Section 3 presents the research findings, and subsequently, section 4 discusses the limitations of the outcomes and suggestions for future research.

Background of the Study

Flight progress strips, introduced as paper-based tools in the 1940s (Weihe, 1953), serve as external representations of aircraft under Air Traffic Control (ATC). They display critical flight details such as callsign, altitude, and speed, aiding controllers in visualizing air traffic and coordinating handovers. The steady increase in air traffic gradually compelled ATCs to adopt higher levels of automation in their operations (Berndtsson and Normark, 1999). However, traditional pen and paper are incapable of updating computer systems or radar screens when ATC directions are sent to pilots. Thus, the concept of EFS, which is used to integrate ATC directives into computer systems, was established (Hurter, 2012). This establishment was further supported by numerous empirical findings indicating that the act of writing on strips and managing the strip board does not significantly contribute to the primary tasks

of air traffic controllers, such as conflict resolution and radar monitoring, with some controllers also finding these activities time-consuming (Edwards *et al.*, 1995). In 1992, the United Kingdom initiated a search for alternatives to replace traditional paper strips with EFS (Hughes *et al.*, 1992). The implementation of EFS in France took place in the late 1990s (Surakitbanharn *et al.*, 2015). The transition from the initial concept of replacing paper flight strips to the implementation of digital flight strips in European ATC facilities spanned a decade and a half. (Huber *et al.*, 2020). In order to enhance capacity and safety in ATC, digital strip systems have replaced paper strips in lower airspace control centres across Europe (Huber *et al.*, 2020). The concept of EFS has evolved to a more advanced stage known as Portable EFS, which harnesses the advantages of paper flight strips while incorporating the distinctive features of EFS (Doble and Hansman, 2002).

In reality, some of the most complete ethnographic studies on ATC methods and culture were conducted more than two decades ago, despite the fact that Conversy and colleagues (2011) stated that practises still develop. Nevertheless, the technologies discovered and validated by Western countries are also permeating Eastern regions with the influence of globalization. Southeast Asian countries are also embarking on the modernization of their ATC systems. While these developing nations are adopting technologies already used in other regions, there is a lack of culturally specific or need-based guidelines for developing effective training plans tailored to their unique market requirements (Surakitbanharn *et al.*, 2015). When deployed in foreign contexts, automated designs and training programmes established for Western cultures may require adaptation and customisation. For instance, in honor cultures like Turkey, factors such as distrust and disuse may necessitate additional measures, like enhanced transparency, to encourage the adoption of automation technologies. In contrast, dignity cultures like the US, with higher trust levels, may require less encouragement. (Chien *et al.*, 2020). Insufficient or incorrect needs assessment or attempting to implement an incompatible automation system for its end users can result in the squandering of significant financial resources and efforts. However, a prerequisite for the implementation of an automated EFS system among a novel user base would entail their inherent willingness and favourable disposition towards embracing such technology. The readiness of ATCs is a critical concern when considering the human factors associated with adaptation of automated systems. This concern arises from the argument that humans are ultimately responsible for systems that have become increasingly complex and are no longer fully understandable or controllable by humans alone (Vallor and Bekey, 2017).

End user attitudes towards accepting various automation products have been investigated in past literature. One notable example is the development of a scale designed to measure individual attitudes towards pilotless aircraft (Molesworth *et al.*, 2016). Attitudinal constructs such as perceived usefulness, trust, perceived

safety and security showed an impact on early adoption of automated buses. Young males who had prior experience with automated buses showed a higher inclination towards using them during the initial stages (Rahim *et al.*, 2023). The attitudes of people towards automated vehicles serve as an indicator of their overall adoption of technology, particularly among early adopters who perceive it as a positive trend (Liljamo *et al.*, 2018).

The literature on assessing attitudes of ATCs towards automation acceptance is minimal worldwide. According to existing literature, the attitudes of ATCs towards future automation demonstrate a notable degree of selectivity, particularly in their acceptance of computer assistance (EUROCONTROL, 2000). The automation acceptance of ATCs is influenced by their attitudinal constructs such as trust in automation, job satisfaction and attitudes towards the use induced by usability and usefulness. Further, less than 8% of variability in automation acceptance can be accounted for by conventional predictors such as age, trust, and job satisfaction (Bekier *et al.*, 2011). The acceptance of higher levels of automation decreased among users after they were exposed to a task that involved automation assistance, indicating that it is possible to modify automation acceptance. In a study conducted using two advanced automation tools, utilizing Sheridan and Parasuraman's (2005) model of automation levels, it was observed that the willingness of ATCs to adopt the new futuristic tools declined when the automated technology assumed control of the decision-making process. Hence, active participation of the operator in the decision-making process plays a significant role in fostering the acceptance of automation (Bekier *et al.*, 2011).

The lack of studies assessing attitudes of ATCs towards accepting automation, specifically in the context of a paper-based ATC system in Sri Lanka, indicates a gap in the existing literature. Understanding the attitudes of ATCs towards major technological changes is crucial for successful implementation and adoption of new systems. Cultural backgrounds can play a significant role in shaping attitudes and reactions towards automation, making it essential to investigate these factors within the specific context of Sri Lanka. Conducting research in this area can provide valuable insights for the development and implementation of automation systems in the country. The study aims to evaluate the attitudes of Sri Lankan air traffic controllers towards EFS. As confirmed through personal communication with Sri Lankan ATCs in April 2023, paper strips were in use at the time across all three units of air traffic control, including Tower control, Approach control, and Area control at all airports throughout the country (Author, personal communication, April 2023). However, the prospect of automating flight strips is not too distant and is driven by two significant factors. First, the rapid advancement of automation aligns with the growth of air traffic, making it increasingly feasible. Second, the recent paper shortage in Sri Lanka further necessitates exploring alternative solutions, including

the automation of flight strips. The recent economic crisis in the first quarter of 2022 in Sri Lanka has had a tremendous impact on numerous sectors of the country's economy, resulting in a significant shortage of paper. For instance, in March 2022 Sri Lankan schools announced an indefinite postponement of term exams. This scarcity is mostly due to a lack of foreign funds to purchase an adequate supply of paper (George *et al.*, 2022; Tripathi *et al.*, 2022), while concurrently, the decreasing cost of display technology opens up new possibilities for utilizing display screens in various innovative ways (Norman, 2013).

Objective of the Study

The primary objective of this study is to examine the influence of psychological factors such as trust, perceived usefulness, perceived ease of use and attitudes on automation acceptance within the context of EFS among Sri Lankan ATCs. By examining the interplay between each other, this research aims to enhance understanding of how these variables collectively shape the acceptance of automation. Additionally, the study seeks to analyze and compare the effects of different demographic factors on the acceptance of automation among ATCs. The practical implications of this study are twofold: firstly, it can provide valuable insights for EFS designers to improve their products and services; and secondly, it can assist management and implementers in effectively managing the change process associated with adopting automation in ATC systems.

The objectives of this study are restated as follows:

- examine how beliefs, attitudes towards automation and trust in automation impact the automation acceptance of Sri Lankan ATCs in terms of EFS; and
- examine how demographic factors impact attitudes, beliefs, trust and automation acceptance of Sri Lankan ATCs in terms of EFS.

Research Questions

Flowing from the above stated objectives, this study aimed to address the following two questions, focusing on Sri Lankan ATCs and their potential utilization of Electronic Flight Strips. First, what is the relationship between the attitudes, beliefs and trust of Sri Lankan Air Traffic Controllers towards accepting Electronic Flight Strips? Second, what impact do demographic factors (age, gender, work unit and automation experience) have on attitudes, beliefs, trust and automation acceptance of Electronic Flight Strips?

Literature Review

Variables Affecting Attitudes Towards Accepting Automation.

The factors influencing the acceptance of automation can be understood through the application of the Technology Acceptance Model (TAM). According to

TAM, there are two primary belief structures that determine attitudes towards the intention and actual use of information technologies: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) (Taylor and Todd, 1995). PU refers to the belief that utilizing information technologies will enhance work performance, while PEOU pertains to the belief that using information technologies requires minimal effort (Venkatesh and Bala, 2008). Despite the empirical validation of TAM and similar user acceptance models, researchers persistently seek to enhance their effectiveness by introducing new external variables (Tarhini *et al.*, 2013; Hu *et al.*, 1999; Holden and Karsh, 2010). Existing literature on the automation acceptance describe several variables useful for understanding embracing of automation by ATCs. Attitude towards automation (ATT) in general, was identified as a key factor influencing the acceptance of automation. However, the strength of this association differed considerably depending on the specific function(s) that were targeted for automation (Bekier *et al.*, 2011). Albarracin *et al.* (2005) define attitude as a psychological tendency to evaluate an object or behavior with varying degrees of favor or disfavor, encompassing subjective positive or negative assessments of people, events, or objects (Robbins and Judge, 2008). Understanding negative attitudes can facilitate their transformation into positive ones, promoting beneficial behaviors (Horst, 1935). In the context of ATC, the concept of trust (T) in automation holds significant importance and cannot be overlooked. T can be defined as the attitude of an individual towards the belief that an automated system will assist in accomplishing their objectives, particularly in situations where uncertainty and vulnerability are present (Lee and See, 2004). Existing literature has consistently shown that T plays a crucial role in determining the level of acceptance towards automated systems (Riley, 1994; Muir and Moray, 1996; Parasuraman and Riley, 1997; Lee and See, 2004). Factors such as age and automation experience (Bekier *et al.*, 2011) act as drivers towards automation acceptance in air traffic management. According to Davis *et al.* (1989) experience of users with automation can be broken down into three areas namely: PU, PEOU and quality. It is evident that individuals who have more positive experiences with automation are more inclined to accept and adopt new technologies (Larson *et al.*, 2009; Dishaw and Strong, 1998).

TAM Model

The TAM model proposed by Davis *et al.* (1989), comprises five components: PU, PEOU, ATT, BI and actual system use. This study focuses on PU, PEOU, ATT and BI. To gauge the acceptance, often referred to as Behavioral Intention (BI), of a newly introduced technology, it entails exploring PU and PEOU of the technology. PU is the belief that the introduction of new technology will positively impact work performance. PEOU is the belief that minimal effort is required to use the new technology (Venkatesh and Bala, 2008). ATT stands for one's psychological

inclination towards accepting automation which is either positive or negative. Both PU and PEOU have a significant direct impact on ATT. BI represents the extend of an individual's intention to use new automation. ATT has a stable association with BI in TAM, and positive ATT is an indication of high acceptance (Yousafzai *et al.*, 2007).

Trust

The role of T in the evaluation of automation acceptance has received limited attention in previous studies. However, those that have examined this relationship consistently report T as a significant and positive predictor of favorable ATT of individuals towards automation (Buckley *et al.*, 2018; Choi and Ji, 2015; Kaur and Rampersad, 2018). T is a direct determinant of BI (Carter and Bélanger, 2005). It has been shown to determine BI or automation acceptance indirectly through PU and PEOU (Pavlou, 2003).

Method

Design

Research Methodology

The primary objective of the study is to investigate how beliefs, attitudes and trust influence the Automation Acceptance (BI) among Air Traffic Controllers in Sri Lanka. Additionally, the study explores the influence of demographic characteristics on these attitudes and automation acceptance. Despite the potential benefits, the study opted not to employ a qualitative approach involving open-ended questions or interviews. Conducting verbal interviews with a considerable number of participants who have demanding rotating shift schedules posed significant challenges, making it unfeasible to meet the time constraints. In contrast, quantitative attitudinal data offers the advantage of enabling longitudinal tracking of societal attitudes, facilitating the examination of changes over time. Additionally, it allows for the comparison of attitudinal differences across different spatial contexts (Eirich and Corbett, 2009). Hence, future research is facilitated by establishing a baseline prior to the adoption of EFS, enabling subsequent investigations into attitudes during its operational use. Thus, the research methodology employed a quantitative approach, utilizing a few structured interviews and a survey questionnaire with closed end questions as the primary research tools. The introduction of EFS as a prospective automation tool to replace the current paper-based system is considered, drawing evidence from literature and interviews conducted with ATCs in the UK and Sri Lanka. The interviews had two main objectives: firstly, to identify any inconsistencies or discrepancies between the functioning of the EFS system and the paper-based strip system in the current operational setup, addressing any gaps between the past literature and the practical implementation. Secondly, the interviews aimed to provide Sri Lankan ATCs with

an accurate understanding and insight into the functioning of the EFS system. The data analysis and findings were based on the quantitative data collected through the survey. Ethical approval for conducting interviews and surveys was obtained from the Cranfield University Research Ethics System (CURES), UK, in 2023, prior to commencing the study.

Research Model

The present study adopts the TAM as a fundamental framework to examine the relationship between ATT and BI. TAM incorporates PU and PEOU as two belief structures that influence ATT and subsequently impact BI. As discussed under literature review, T is identified as a construct that influences BI, and this construct impacts ATT. To explain the behavior of automation acceptance broadly, we add T to the TAM model and develop study hypotheses for the extended model (Figure 1).

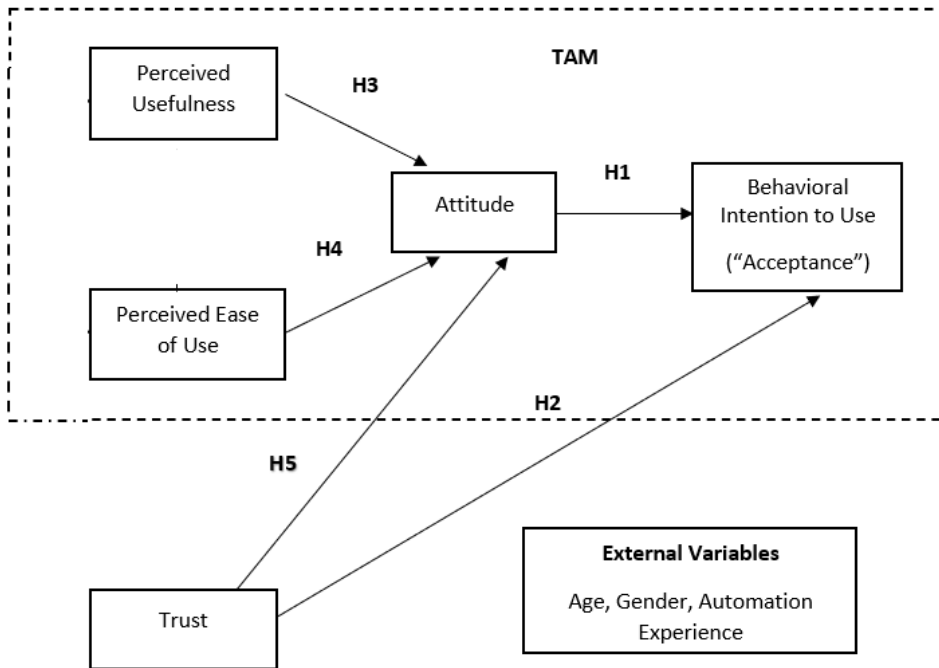


Figure 1: Research Model. The black arrows indicate the hypothesized relationships. The area within the dotted lines is adapted from original TAM model by Davis et al. (1989)

Hypothesis 1. ATT has positive effect on EFS Automation acceptance (BI) and is significant

Hypothesis 2. T has positive impact on EFS Automation acceptance (BI) and is significant

Hypothesis 3. PU positively influences ATT to use EFS and is significant

Hypothesis 4. PEOU has positive effect on ATT to use EFS and is significant

Hypothesis 5. T has positive impact on ATT to use EFS and is significant

Research Design

The main objective of this study was to determine what impact the identified variables PU, PEOU, ATT and T have on BI of Sri Lankan ATCs in terms of EFS, thereby providing guidance to EFS designers and management to plan accordingly. To achieve this, an extensive literature review was conducted, forming the basis for hypothesis development and analysis. The review also guided the design of interview protocols and supported the creation of two scenarios to simulate the functionality of the EFS system, ensuring participants, who had no prior experience with the system, could gain meaningful insights into its features. Subsequently, a questionnaire was developed and distributed to a group of participants for testing purposes. A pilot study was then carried out to assess and refine the survey instrument, followed by reliability testing to assess the consistency and stability of the instrument in measuring the intended constructs or variables. Once a sufficient number of responses were collected, the data were analyzed, hypotheses were tested, and conclusions were drawn based on the findings.

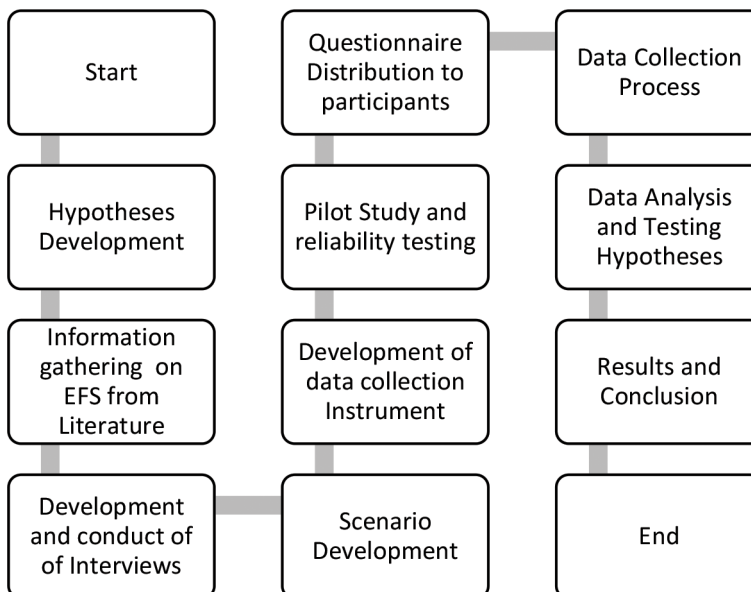


Figure 2. Research Design

Participants

The study was conducted with the sole air navigation service provider in Sri Lanka, which included diverse ATC groups (Tower, Approach, Area) in various locations totaling 64 (Tower-28, Approach-16, Area-20) operational level air traffic control officers. Survey invitations were distributed to the entire population, and 48 responses were received out of a target population of 64. Table 1 presents the characteristics of the sample of 48 participants.

Table 1. Demographic Characteristics of Sample (N=48)

Characteristic	Group	Count	Percentage
Gender	Male	30	62.5%
	Female	18	37.5%
Age	22-43	35	72.9%
	44-65	13	27.1%
Work Unit	Tower	21	44.8%
	Approach	16	33.3%
	Area	11	22.9%
Automation Experience	No Experience	5	10.4%
	Less than 10 years	25	52.1%
	More than 10 years	18	37.5%

The majority of participants were male ATCs (62.5%), were between the age range of 22-43 years (72.9%), worked at Tower (44.8%), and had less than 10 years of experience in automation (52.1%). Only 5 (10.4%) ATCs among respondents had no prior experience in automation. The rest of the ATCs consisted of 16 (33.3%) Approach Controllers, 11 (22.9%) Area Controllers, 18 (37.5%) female ATCs and 18 (37.5%) ATCs with more than 10 years of automation experience.

Materials

Scenarios

An information leaflet was prepared to accompany the questionnaire, providing relevant details about EFS for individuals with limited prior knowledge. This information leaflet included two scenarios derived from the literature review and interview insights with ATCs from Sri Lanka and the UK, outlining different ways of managing traditional paper strips and EFS to achieve the same work task or goals by the controller (Appendix A). In addition to insights from interviews and literature, factors such as benefits, drawbacks, and human factor implications were considered in an unbiased manner when developing the scenarios.

Scenario-1 elucidates the handling of routine tasks within a paper-based system, while scenario-2 demonstrates the task handling within an EFS system, providing a balanced perspective on both approaches. Prior to completing the questionnaire, participants were provided with the online information leaflet (Appendix B) via emails which they were instructed to review in advance.

Procedure

Interviews

The ethical approval was first acquired to conduct interviews with ATCs and to gather data via a questionnaire. Prior to their participation, the interviewees, who voluntarily took part in the study, were requested to provide informed consent by signing the ethics consent form. The interviews were conducted through an online platform, using structured questions with each session lasting between 15 to 20 minutes. The work tasks identified in the literature (Mackay, 1999; Huber *et al.*, 2020), were further validated by experienced ATC officers to address any variations that may have arisen due to temporal gaps. The handling of paper strips was validated by ATC officers in Sri Lanka who still utilize paper-based strips, while the EFS handling was validated by ATC officers in the UK.

Survey

The primary aim of this survey-based questionnaire was to evaluate beliefs, attitudes and trust towards the acceptance of automation (EFS) among ATCs in Sri Lanka. The survey instrument utilized a self-administered questionnaire comprising 20 closed-ended questions in English language. The questionnaire was constructed in Qualtrics (Qualtrics, 2023) and distributed to respondents online for convenience, accessibility, and attractiveness. Further, for greater accessibility the questionnaire link and scenario leaflet were published in Sri Lankan ATCs' common "Whatsapp" group. On average, respondents took approximately 4 to 6 minutes to complete the questionnaire. Data collection lasted from 19th to 27th of June 2023. Out of the total 64 questionnaires submitted, 54 responses were received. Only 48 were fully completed and included in the study.

The questionnaire was divided into several sections (Appendix C). The initial section of the questionnaire was dedicated to gathering demographic information, including age, gender, ATC work unit and years of automation experience. The second section was dedicated to exploring PU, the third section examined PEOU and the fourth section investigated T in Automation. The fifth section assessed the ATT using questions proposed by Davis *et al.* (1989). The final section focused on BI. The four questions under PU, all four questions under PEOU, and the question under BI were formulated using the basic TAM questionnaire (Turner, 2008). The questionnaire utilized a five-point Likert scale ranging from "Strongly Agree" to

“Strongly Disagree” to assess the level of agreement with the questions pertaining to PU, PEOU and T. The section on BI included a single-item question, which also used five-point Likert scale from “Strongly Agree” to “Strongly Disagree”. Although single-item measures are not always optimal, they are acceptable for certain variables (Scarpello and Campbell, 1983).

Analysis

To evaluate whether the Likert scale represents a one-dimensional measurement, its internal consistency was assessed using Cronbach’s alpha (Cronbach, 1951). Descriptive statistics were used to analyze individual item scores, including frequency and percentages, as well as scale scores using the mean and standard deviation. Subsequently, a sensitivity analysis was performed to identify and remove outliers from the data. The analysis was then carried out using the outlier-free dataset. Since small sample sizes ($n < 50$), Shapiro-Wilk test (Shapiro and Wilk, 1965) was conducted for each variable distribution under the five variables in each statistical analysis. The results showed the presence of at least one or two variables with non-normal distributions. Hence, non-parametric statistical methods were mainly employed, due to nonnormality of independent variables PEOU, ATT, T, BI and the ordinal nature of the dependent variable BI.

Each hypothesis (H1 to H5) was examined using Spearman Correlation (Spearman, 1904) to determine how PU, PEOU, ATT, T influence BI.

Equal sample sizes of 11 were considered from each group to analyze whether the work unit (Tower, Approach, Area) has an impact on attitudinal variables (PU, PEOU, ATT and T), as the Area Controller count was 11. Non-parametric Kruskal-Wallis test (Kruskal and Wallis, 1952) was conducted for the comparison of three independent samples. Significant findings were subsequently further compared using the non-parametric Mann-Whitney test (Mann and Whitney, 1947).

Additionally, the relationships between the attitudinal variables (PU, PEOU, ATT and T) and factors (age, gender and automation experience) were examined using independent sample t-tests and non-parametric Mann-Whitney test. To test automation experience on the variables, the group categorized as “No experience” was excluded from the analysis concerning the influence of inconsistencies and the notably small sample size ($N=5$). Moreover, the presence of an Area Controller without any prior automation experience is difficult to comprehend.

An alpha level of .05 was considered for a confidence interval of 95% for all statistical tests. Analysis was carried out using IBM SPSS Statistics (IBM Corp., 2023).

Results

Response Rate

A total of 48 complete responses were received from a target population of 64, resulting in a 75% response rate. A sample size of 10% to 30% is a satisfactory representation of parent population (Mugenda and Mugenda, 2012). Further, Roscoe's Rule of Thumb (Roscoe, 1975) recommends sample sizes between 30 to 500 which represent 10% of the target population as acceptable. Therefore, sample size 48 with 75% representation was considered as satisfactory for the statistical analysis.

Validity and Reliability Analysis

A construct is considered reliable if its Cronbach's alpha is above 0.70 (George and Mallery, 2003). The reliability of the construct in this study was assessed using this criterion, resulting in a high alpha value ($\alpha = 0.94$), which exceeds the 0.70 threshold. The Trust scale with four items found unacceptable ($\alpha = .13$). Upon review, items T3 and T4 were found to contribute to the low alpha value. Removing these items significantly improved the scale's reliability, raising the alpha to an acceptable level of 0.79. Since Cronbach's alpha does not provide reliability estimates for single items, BI was not considered individually. The results are summarized in Table 2.

Table 2. Reliability Statistics

Constructs	No. of Items	Alpha (α)	Internal Consistency
PU	4	.88	Good
PEOU	4	.78	Acceptable
ATT	3	.88	Good
T	2	.79	Acceptable
Overall	14	.94	Excellent

Outlier Treatment

The box plot diagrams in descriptive analysis revealed the existence of outliers in all the four independent variables and as well as in the dependent variable. The values below $Q1$ (first Quartile) - $1.5 * IQR$ (Interquartile Range) or above $Q3$ (Third Quartile) + $1.5 * IQR$ were considered outliers. A total of 5 outliers were observed, accounting for approximately 10% of the entire dataset, and several of them were present in multiple variables. As these outliers could not be attributed to sampling error (as all population members received invitations) or data entry mistakes (as the questionnaires were self-administered), a sensitivity analysis was performed to determine their retention. An independent sample t-test was performed with and

without the outliers to evaluate the effect of automation experience, comparing groups with “Less than 10 years” and “More than 10 years” of experience. Results showed no significant differences between groups across variables (PU, PEOU, ATT, T and BI) when outliers were included. However, significant differences emerged for ATT, T and BI after removing the outliers. A Mann-Whitney test, which is robust to outliers, yielded similar results: no significant differences with outliers but significant differences in ATT, T and BI after their removal. Due to the effect of outliers on the primary findings and effect sizes, they were excluded from the main analysis.

Participants' Profile

The sample demographic presented in table 1 revealed that 73% of the sample consisted of individuals aged 22 to 43 years, indicating an overrepresentation of this age group. Similarly, the male representation in the sample was approximately 63% and 62% possessed less than 10 years of experience with automation. Work unit wise, Tower Controllers had a slight over representation accounting for 45% of the sample.

Statistical Analysis

Descriptive Analysis

PEOU obtained the highest mean score of 4.05 ($SD=0.69$), indicating a positive perception of EFS's Ease of Use. Notably, PEOU3 scored highest ($M=4.15$, $SD=0.94$), showing confidence in acquiring EFS skills. Highest percentage agreement (62.5%) also accounted under PEOU for PEOU1, indicating that many respondents perceive they can easily learn EFS handling. T had the lowest mean ($M=3.77$, $SD=0.81$). However, respondents positively perceived automation as trustworthy, with T2 recording a mean score of 3.52 ($SD=0.94$), indicating a low perception of automation safety. PU had the lowest item score (PU3, $M=3.44$, $SD=0.99$) as well as the lowest percentage for “agree” (37.5%) with highest percentage being “neutral” (17%), suggesting EFS's limited usefulness in decision-making and inability of the respondents to comprehend whether or not EFS contribute in decision making. Around 80% of the respondents have positive attitudes towards automation (ATT, $M=3.99$, $SD=.91$) and are willing to accept automation (BI, $M=3.96$, $SD=1.07$). Table 3 below and Table (iv) in Appendix D depict the descriptive statistics for scale values and scale items, respectively.

Table 3. Descriptive statistics for Scale Values

Variable	Min	Max	<i>M</i>	<i>SD</i>
PU	1.00	5.00	3.78	.89
PEOU	1.50	5.00	4.05	.69
ATT	1.33	5.00	3.99	.91
T	1.5	5.0	3.77	.81
BI	1	5	3.96	1.07

Note: $n=48$ for all variables

Effect of Work Unit, Age, Gender and Automation Experience

The work unit of the respondents had no significant effect on PEOU, ATT, T and BI (Table 5). However, PU differed significantly across the three units ($H(2) = 7, p = .03$). Specifically, Tower and Area Controllers reported similar levels of perceived usefulness of EFS, while Approach Controllers rated EFS as less useful than both Tower ($p = .012$) and Area Controllers ($p = .046$) with large and medium effect sizes $r=.54$ and $r=.42$, respectively. Table 4 and 5 depict descriptive statistics for all variables per work unit and Kruskal Wallis test results, and the results of Mann Whitney tests.

Table 4. Descriptive statistics and Kruskal’s Wallis test results for variables per Work unit

Variable	Work Group									H (2)	<i>p</i>
	Tower			Approach			Area				
	Median	M	SD	Median	M	SD	Median	M	SD		
PU	4.25	4.32	.51	4.00	3.61	.67	4.25	4.25	.47	7	.03*
PEOU	4.50	4.38	.32	4.25	4.07	.78	4.00	4.25	.47	1.16 (ns)	.56
ATT	4.33	4.30	.55	4.00	4.33	.49	4.33	4.42	.45	.44 (ns)	.80
T	4.00	4.00	.39	3.50	3.91	.83	4.00	4.23	.56	1.57 (ns)	.46
BI	4.00	4.45	.52	4.00	4.27	.65	4.00	4.45	.52	.55 (ns)	.76

Note: $n= 11$ for all groups

* $p<.05$ ns: non-significant

Table 5. Results for Mann Whitney tests for work units under PU

Variable	Work Group	Mean Rank	<i>U</i>	<i>z</i>	<i>p</i>	<i>r</i>
PU	Tower	14.95	22.5*	-2.52	.012	.54
	Approach	8.05				
	Area	14.23	30.5*	-1.99	.046	.42
	Approach	8.77				

Note: *n*= 11 for all groups

**p*<.05

There were no significant differences in PU, PEOU, ATT, T and BI across the two age groups or the two gender groups. Table 6 and 7 summarize descriptive statistics and results of t- tests and Mann Whitney tests (per age and gender group), respectively.

Table 6. Descriptive statistics and results of independent t-tests per Age and Gender Group

Group Type	Variable	Group	<i>n</i>	<i>M</i>	<i>SD</i>	Mean Difference	Lower <i>CI</i> _{95%}	Upper <i>CI</i> _{95%}	<i>t</i> (41)	<i>p</i>	Cohen's <i>d</i>
Age	PU	22-43	31	3.93	.74	-.11	-.58	.35	-.50 (ns)	.62	.67
		44-65	12	4.04	.45						
	PEOU	22-43	31	4.17	.50	-.06	-.43	.31	-.33 (ns)	.74	.58
		44-65	12	4.23	.63						
Gender	T	22-43	31	3.81	.72	-.24	-.73	.26	-.96 (ns)	.34	.72
		44-65	12	4.04	.72						
	ATT	Males	26	4.24	.55	.03	-.33	.39	.16 (ns)	.87	.58
		Females	17	4.22	.61						
T	Males	26	4.00	.68	.32	-.12	.77	1.47 (ns)	.15	.71	
	Females	17	3.68	.75							

ns: non-significant

Table 7. Descriptive statistics and Mann-Whitney test results per Age and Gender Group

Group Type	Variable	Group	<i>n</i>	Median	<i>M</i>	<i>SD</i>	Mean Rank	<i>U</i>	<i>z</i>	<i>p</i>
Age	ATT	22-43	31	4.00	4.14	.58	20.03	125 (ns)	-1.71	.09
		44-65	12	4.50	4.47	.48	27.08			
	BI	22-43	31	4.00	4.23	.62	21.44	168.5 (ns)	-.54	.59
		44-65	12	4.00	4.33	.65	23.46			
Gender	PU	Males	26	4.25	4.05	.75	24.6	151.5 (ns)	-1.74	.08
		Females	17	3.75	3.82	.51	17.91			
	PEOU	Males	26	4.12	4.17	.52	21.65	212 (ns)	-.23	.82
		Females	17	4.25	4.21	.56	22.53			
	BI	Males	26	4.00	4.31	.55	22.71	202.5 (ns)	-.52	.60
		Females	17	4.00	4.18	.73	20.91			

ns: non-significant

Automation experience had no significant effect on PU and PEOU (Table 10). However, ATT, T and BI of respondents significantly differed between the two experience groups. Respondents with over 10 years of automation experience demonstrated significantly higher positive attitudes toward automation ($p = .005$), greater trust ($p = .01$), and a stronger inclination to accept EFS ($p = .04$) compared to those with less experience, with moderate effect sizes $r=.45$, $r=.41$ and small effect size $r=.32$, respectively. Table 8 and 9 summarize descriptive statistics and results of t- tests and Mann Whitney tests per automation experience group.

Table 8. Descriptive statistics and independent t-tests results for PU and PEOU per Automation Experience Group

Variable	Group	<i>n</i>	<i>M</i>	<i>SD</i>	Mean Difference	Lower $CI_{95\%}$	Upper $CI_{95\%}$	<i>t</i> (36)	<i>p</i>	Cohen's <i>d</i>
PU	<10 years	23	3.84	.69	-.31	-.74	.11	-1.50 (ns)	.14	.63
	>10 years	15	4.15	.51						
PEOU	<10 years	23	4.11	.49	-.27	-.62	.07	-1.62 (ns)	.11	.51
	>10 years	15	4.38	.54						

ns: non-significant

Table 9. Descriptive statistics and Mann-Whitney test results for ATT, T and BI per Automation Experience Group

Variable	Gender Group	<i>n</i>	Median	<i>M</i>	<i>SD</i>	Mean Rank	<i>U</i>	<i>z</i>	<i>p</i>
ATT	<10 years	23	4.00	4.06	.56	15.52	81**	-2.83	.005
	>10 years	15	4.67	4.58	.43	25.60			
T	<10 years	23	3.50	3.67	.61	15.85	88.5*	-2.58	.01
	>10 years	15	4.00	4.30	.68	25.10			
BI	<10 years	23	4.00	4.09	.67	16.85	111.5*	-2.02	.04
	>10 years	15	5.00	4.53	.52	23.57			

* $p < 0.05$, ** $p < 0.01$

Correlations Between Variables

A random sample of size 43 (<50) free of outliers was selected, and Shapiro-Wilk test was conducted to test the normality. Results showed that distributions for means of PEOU ($W=.94, p=.02$), ATT ($W=.90, p=.001$), T ($W=.94, p=.03$) and BI ($W=.77, p<.001$) departed significantly from normal while there was no evidence for the means distribution of PU ($W=.95, p=.07$) to be non-normal. Due to non-normality of variables PEOU, ATT, T and BI and BI being ordinal, the study conducted a Spearman correlation analysis to determine statistically significant relationships between the variables.

Pearson correlation test is robust with respect to skewness, nonnormality (Pearson, 1931; Dunlap, 1931; Havlicek and Peterson, 1976) and scale type (Havlicek and Peterson, 1976). Thus, the study also conducted a Pearson correlation analysis to ascertain the validity of the findings. The results of Pearson correlation test revealed the same correlations among the variables with differing magnitudes (Appendix E) to the results of Spearman test given in Table 10, hence increasing the validity of the findings. Correlation strengths were interpreted using Dancey and Reidy’s (2004) correlation categorization.

Table 10. Descriptive Statistics and Spearman Correlations for Study Variables

Variables	<i>M</i>	<i>SD</i>	1	2	3	4	5
PU	3.96	0.67	-				
PEOU	4.19	0.53	.63**	-			
ATT	4.23	0.57	.54**	.62**	-		
T	3.87	0.72	.49**	.50**	.46**	-	
BI	4.26	0.62	.64**	.66**	.59**	.54**	-

Note: $n=43$ for all variables

** $p < .01$

The correlation analysis results confirmed all proposed hypotheses, as shown in Table 11. Specifically, PU demonstrated significant positive correlations with PEOU, BI, ATT and T, supporting H3. PEOU also had significant positive correlations with ATT, BI and T, confirming H4. Additionally, ATT and BI were positively correlated, supporting H1. Finally, T showed significant positive correlations with both BI and ATT, thus supporting H2 and H5.

Table 11. Results of Correlation Analysis

Hypothesis	Hypothesis	Result	<i>r</i>	<i>p</i>
H1	ATT has positive effect on BI	Accepted	.59**	<.001
H2	T has positive impact on BI	Accepted	.54**	<.001
H3	PU positively influences ATT	Accepted	.54**	<.001
H4	PEOU has positive effect on ATT	Accepted	.62**	<.001
H5	T has positive impact on ATT	Accepted	.46**	<.01

** $p < 0.01$

Summary of Findings

The research findings revealed that the work unit of respondents had no significant effect on PEOU, ATT, T and BI. Tower and Area Controllers perceived the usefulness of the EFS system similarly, whereas Approach Controllers perceived it as less useful. Age and gender did not show significant differences in PU, PEOU, ATT, T and BI. However, respondents with more than 10 years of automation experience displayed a more positive attitude and greater trust towards automation,

and they were more willing to accept the EFS system compared to those with less experience. The study confirmed strong positive correlations between PU and PEOU, significant moderate positive correlation between PU and ATT, and strong positive correlation between PEOU and ATT. Additionally, ATT showed a moderate positive correlation with BI, and T had a moderate positive correlation with ATT and BI. All five hypotheses were satisfied based on these results.

Discussion

Discussion of Results and Study Implications

The main purpose of this study was to determine what impact the identified variables PU, PEOU, ATT and T have on BI of Sri Lankan ATCs in terms of EFS and thereby provide guidance to EFS designers and management to plan accordingly. To accomplish this goal, two scenarios were created to educate Sri Lankan ATCs about the strengths and limitations of EFS and traditional paper strips handling. Subsequently, feedback was obtained from ATCs at various operational levels (Tower, Approach, Area) to evaluate their beliefs, attitudes, and levels of trust in accepting automation by means of TAM with T incorporated into it. The results from correlation analysis revealed that all the relationships we used in TAM were positively and significantly correlated (supporting hypotheses H1, H3 and H4) including the relationships with external variable T (supporting H2 and H5).

T had a significant impact on BI which is consistent with previous research findings (Riley, 1994; Muir and Moray, 1996; Parasuraman and Riley, 1997; Lee and See, 2004). T showed a moderate, positive association with BI which further replicates the important relationship of T and BI in Trust and TAM model introduced by Gefen *et al.* (2003). EFS is primarily an efficiency tool rather than a decision support tool. Half of the respondents did not accept it as a decision-making tool. Prior research on ATCs indicates that Trust is a significant predictor of automation acceptance, provided the tool does not assume decision-making authority from ATC in safety-critical situations (Bekier *et al.*, 2011). Further, only one in eight ATCs in the population strongly trusted automation as safe. Combined, these results justify the existence of association between T and BI and the moderate strength of the relationship. Hence, designers should prioritize building trust in the safety aspects of EFS and persuading ATCs about its controllability and supportive nature, keeping the controller in the loop for decision making in safety-critical circumstances. This relationship further suggests that for low-level automation, BI is not only affected by ATT but also by T, and hence should be incorporated in TAM.

Apart from the indirect influence of PU and PEOU on BI through ATT, they showed positive moderate correlation with BI which depicted a direct influence that aligns with previous research findings that state PU (Lee *et al.*, 2003, Davis and Davis, 1989) and PEOU (Luarn and Lin, 2005; Wei *et al.*, 2009) significantly impact BI. Beliefs influence intentions both directly, and indirectly through attitude (Bagozzi, 1982). Thus, though this revelation is beyond the scope of this study, PU and PEOU equally and highly influence BI than the direct impact of ATT which is again not explained in TAM. Hence, designers should emphasize the usefulness and ease of use in designing EFS to ATCs.

T had a positive moderate correlation with ATT which is in line with many prior research. This correlation is slightly weaker than the effect of PU and PEOU on ATT. However, this indicates that PU and PEOU alone do not adequately describe ATT. Thus, this finding reassures that T should be incorporated into the TAM model as suggested by many other researchers (Wu and Chen, 2005).

ATT had a significant positive association with BI of moderate strength which is reassuring prior research findings (Wu and Chen, 2005). This may be partly due to the indirect channeling of PU, PEOU and T through ATT which are direct influencers of BI (according to the findings of current study). The respondents have positively perceived EFS as useful in their performance improvement and easy to use, which, together with their positive trust towards the automation contributed to their positive attitude towards EFS. Furthermore, ATT was found to have a stronger correlation with BI compared to T.

Overall, ATCs show a stronger preference for technological features. These include improved performance or perceived usefulness (PU) and ease of use (PEOU). Trust (T) in safety features is less influential in shaping their attitude (ATT) toward EFS. Ease of use (PEOU) is the most dominant factor in their acceptance of automation (BI).

Among the demographic factors, age and gender had no significant impact on any of variables whereas work unit and automation experience showed significant influence on some of the variables that can be explained as follows.

Work unit was an influential demographic factor on PU. Tower and Area Controllers perceived the usefulness (PU) of the EFS system at a similar level, whereas Approach Controllers perceived it as less useful. In other words, Approach Control perceived a significantly lower level of improvement of their performance due to introduction of EFS. A previous study on Australian ATCs states that they perceived automated tools to be useful when those tools offered assistance and support to the controller (Langford *et al.*, 2022). The finding may be explained by the level of exposure of each unit to the automation or the extent to which each Sri Lankan ATC units use handwritten strips. Approach Control serves as the intermediary unit in the control sequence, positioned between

the Tower and Area Controllers. Typically, flight strips are generated through existing Flight plan printing system with data input either from the Tower or Area. Thus, limited time spent on data entry or manual writing of strips and more often getting a printed strip can be suggested as a probable cause for Approach unit as not seeing EFS as useful in further improving their performance compared to other two units. However, there is no existing literature to either support or refute this explanation. This finding may be specific to Sri Lankan context based on the way they handle operations.

Automation experience had no significant effect on PU and PEOU. Some studies state that prior experience in specific technology positively influences PU and PEOU (Kim and Malhotra, 2005; Dishaw and Strong, 1998) while some shows no effect on PU (Jackson *et al.*, 1997). The lack of significant influence of prior automation experience on PU and PEOU may be attributed to the absence of prior experience with the specific target automation (EFS). Participants' perceptions of usefulness and ease of use were likely based on the two provided scenarios, which enabled similar perceptions among all participants without direct interaction with the actual EFS system. However, automation experience was significant in three aspects (ATT, T, BI). ATCs with relatively more automation experience showed a more positive attitude towards automation, trusted automation more and were more positive on accepting automation. These findings agree with previous literature (Bekier *et al.*, 2011; Kim and Malhotra, 2005). An explanation to this can be found in Bekier *et al.* (2011) who claimed that ATCs with prior highly positive automation experience are likely to accept new automation if it serves a "supportive" function. Other studies also state that more positive prior experience with automation leads to acceptance (Larson *et al.*, 2009; Dishaw and Strong, 1998).

Age was not found significant enough to have any impact on attitudes, belief, trust and acceptance. This contrasts with the majority of prior studies, which suggest that older ATCs or older users exhibit less willingness to accept automation compared to younger ones (Bekier *et al.*, 2011; Hudson *et al.*, 2017; Ivanov *et al.*, 2018). One probable cause may be the categorization of age (22-43 years & 44-65 years) in the study was not effective enough to differentiate between the young and old. However, this result aligns with previous study done on ATCs regarding the introduction of a hypothetical conflict detection tool in which age did not significantly affect automation acceptance (Bekier *et al.*, 2011).

The fact that both males and females showed no significant difference in PU, PEOU, ATT, T or BI is quite unexpected. Previous studies, though not specifically conducted in the context of ATC show that generally males have more acceptability towards new technology than females (Rahim *et al.*, 2023; Schoettle and Sivak, 2014). A study done on ATC context, has found gender to have

no effect on conflict resolution performance, workload and situation awareness (Trapsilawati *et al.*, 2022). Gill and Grint (1995) argue that women are often expected to adopt traditionally masculine ways of interacting with technology. Thus, one possible explanation for this observation is that the demands of the ATC job role outweigh gender differences.

Limitations of the Study

The study findings can be limited since ATC population is a very specific, small community of 64 of which only 75% participated in the study. In subsampling, the sample sizes were further reduced, hence it might have had some impact on the results to differ from past research findings. Another limitation is that the attitudes and trust levels were based on the two scenarios that were introduced to them and a majority of them had not yet encountered an EFS. Thus, the results might vary if they had exposure to an operational EFS system.

Future Directions

More insights may be drawn if future research could consider a longitudinal study to examine the changes over time while tracking changes in attitudes while EFS is in operational use. Another possible suggestion for future research is to investigate whether the three main ATC work units (Tower, Approach and Area) perceive usefulness of automation differently in the global context. Moreover, research should be conducted in future to consider how other factors such as cultural context and also personality traits of ATCs affect beliefs, attitudes, trust and automation acceptance.

Conclusion

Attitudes toward EFS are influenced not only by Perceived Usefulness and Perceived Ease of Use but also significantly by Trust. Therefore, the designers should focus on building trust in the safety aspects of EFS and persuading ATCs about its controllability and supportive nature, particularly in safety-critical situations where the controller's involvement is crucial. Designers must emphasize the usefulness and ease of use of EFS to ATCs, as these aspects have a higher influence on attitude toward EFS than direct trust impact. However, Perceived Usefulness and Perceived Ease of Use alone are not sufficient to fully describe attitude, indicating the need to incorporate trust in the TAM model for a more comprehensive understanding. The dominant attitude construct among ATCs is a minimum effort in use of EFS. This highlights the significance of ensuring ease of use and efficiency in the design of EFS systems. Management should leverage ATCs with substantial automation experience as valuable assets to promote the adoption of EFS. Additionally, they should emphasize the utility of EFS to approach control by showcasing various other features such as integration to digital flight plans, available lists of upcoming traffic,

ability to replay EFS display along with radar replay for incident analysis (Author, personal communication, 2023) not just the elimination of paper strips.

Conflict of Interest

The author has no conflict of interest to declare.

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Supplementary Material

Appendix A.

Table (i). Identification of the current differences in handling of EFS compared to that of Paper Strips

Work goal of controller	Paper strips handling	EFS handling
Adding a new aircraft to controlled traffic	Select a suitable coloured paper strip depending on arrival or departure, Insert it in a strip holder picked from a container, Place it in the active strip bay	Added automatically in to pending bays or can manually populate with call sign and type of aircraft with the ability to fill in further details
Inform or remind stand by controller or another controller of an action related to an aircraft	Keep the relevant strip noticed by keeping a hand on it until the relevant action is coordinated and fulfilled	Highlight the relevant strip or specific field in the strip that needs further action
Entering Clearances	Manual writing using an ink pen from one hand while holding the strip holder from the other hand	An SID or STAR is populated automatically or by clicking on the clearance box it allows to enter manually
Maintain aircraft in the order of landing	Might use both hands to remove and place the strip holders in correct order of landing on the strip bay	system functionality allows the controller to drag and drop the strips across the EFPS display including establishing a landing order, departure sequence, highlighting ground conflicts
Handing over the responsibility of an aircraft to another controller in controlling sequence	If another controller is taking over control of same position the strips will remain at the same place in the same strip bay If a controller in next controlling unit is taking over then the same strip holder is physically being handed over or the next controller writes up a new paper strip with required details and insert in a holder and place on his strip bay	A transfer bay between adjacent, intermediate or final controllers Or A pending strip is populated and exist in the Flight plan system or A strip transfer box to specify whom to transfer

Note: Adapted partly from “Table 2. Direct comparison between controllers’ interactions with paper and digital flight strips to achieve their goals.” Huber, S., Gramlich, J., & Grundgeiger, T. (2020). From paper flight strips to digital strip systems: Changes and similarities in air traffic control work practices. *Proceedings of the ACM on Human-Computer Interaction*, 4(CSCW1), 28, 1–21. <https://doi.org/10.1145/3392833>, p. 28:15. Other sources: Interviews with Sri Lankan ATCs and UK ATCs.

Appendix B.

Scenario 1 (An ATC working in Conventional Paper Strip System) and Scenario 2 (An ATC working in Electronic Flight Strip System)

SCENARIO BASED COMPARISON BETWEEN PAPER FLIGHT STRIPS & ELECTRONIC FLIGHT STRIPS




Scenario 1- An ATC working in conventional paper strip system

Controller-A after taking over the control position checks incoming flight plans in printed file or in AMHS system manually, then loads paper strips in to strip holders manually by moving the chair or turning the body from working position to strip holder rack. The controller can miss witnessing traffic outside the tower or radar screen at this point. An aircraft is calling in the VHF, but the controller's both hands are busy in strip loading and writing the flight plans. The controller stops the current strip loading work and gives priority to listening to aircraft. The controller looks for the call sign of the flight in the already written strips but cannot find it. The controller then quickly takes a newly loaded strip according to the color code and starts taking down the necessary details of the pilot's transmission. Then places that strip on the active bay according to the correct order by using both hands to move the strip holders.

At the same time another aircraft is calling in VHF asking for a level change. The controller immediately looks at the equivalent strip to look for current level, but the previous controller's hand writing is illegible; therefore, the controller cannot understand the level given. The controller says "Stand by" to the aircraft for level change because he cannot make a decision without clearly understanding the current level. He hands over the strip to another controller to get the level clarified. It was not returned back; due to workload the controller forgets to take it back from him. The controller then gets busy with traffic. After 20 minutes the same aircraft is asking for amended level. The controller looks for the flight strip, it is not on the active strip bay. The controller gets confused. If a strip is misplaced in this way, then the crucial information needed for an incident or accident investigation is lost.

Figure (i). Scenario 1 (An ATC working in Conventional Paper Strip System)

Scenario 2- An ATC working in Electronic Flight Strip system




Scenario 2- An ATC working in Electronic Flight Strip system

Controller-B, after taking over the control position, accesses incoming flight plans electronically through the system's interface. Instead of dealing with printed files or manual systems, the flight plans are readily available in the Electronic Flight Plan system. So, no need of a strip printer or paper. Controller-B retrieves the necessary information from the system without the need to physically move or adjust their seating position. While processing the electronic flight strips, Controller-B receives an aircraft call on the VHF radio. Unlike in Scenario A, Controller-B's hands are not occupied with manual strip loading but only with writing tasks. Therefore, Controller-B can immediately prioritize listening to the aircraft communication without interruption, by highlighting the fields in the strip he is currently writing that need further actions. The call sign of the aircraft is quickly located in the electronic flight strip display, eliminating the need for searching through physical strips. Simultaneously, if another aircraft contacts Controller-B for a level change then Controller-B promptly locates the corresponding strip on the electronic display to check the current level.

There is no issue with illegible handwriting since the information is digitally recorded. Controller-B accurately understands the current level and can make an informed decision. If Mode S is connected, then the controller is informed of the wrong levels of aircraft by the strip system by highlighting the level field in red color. However, if Controller-B decides to hand over the strip to another controller then the strip is electronically designated to desired adjacent, intermediate or final controller. However, there is possibility of strip being sent to wrong destination if transfer is done incorrectly. If so, it is difficult to be traced. For accident or incident investigation purposes the electronic strip data display can be replayed along with the radar display. The system can go wrong due to technical reasons such as server capacity, poor maintenance, etc

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3. Insights from the UK and Sri Lanka Air Traffic Controllers.

Figure (ii). Scenario 2 (An ATC working in Electronic Flight Strip System)

Appendix C.

Components of the Questionnaire for data collection

Table (ii) Questionnaire Part 1- Demographics

Variable	Value		
Age	0: 22-43	1: 44-65	
Gender	0: Male	1: Female	
Work unit	0: Tower	1: App	2: ACC
Automation Experience	0: No experience		
	1: Less than 10 years		
	2: More than 10 years		

Table (iii) Questionnaire Part 2- Variables in the Research Model

Variable	Item	SD	D	N	A	SA	
PU	PU1	Using Electronic Flight Strips can help me improve my traffic controlling performance	1	2	3	4	5
	PU2	Electronic Flight Strips help me be more productive in job tasks	1	2	3	4	5
	PU3	Electronic Flight Strips improve my decision making in traffic controlling tasks	1	2	3	4	5
	PU4	I would find Electronic Flight Strips system useful in my job	1	2	3	4	5
PEOU	PEOU1	Electronic Flight Strips will be easy for me to learn	1	2	3	4	5
	PEOU2	Electronic Flight Strips make it easy for me to achieve my desired work tasks	1	2	3	4	5
	PEOU3	I am confident that I can easily acquire Electronic Flight Strip handling skills	1	2	3	4	5
	PEOU4	Electronic Flight Strips are easy to use	1	2	3	4	5
T	T1	I trust automation as an Air Traffic Controller	1	2	3	4	5
	T2	I feel automation is safer	1	2	3	4	5
	T3	Automation is unpredictable	1	2	3	4	5
	T4	Automation is unreliable	1	2	3	4	5
ATT	ATT1	Using Electronic Flight Strips is a good idea	1	2	3	4	5
	ATT2	Using Electronic Flight Strips is a wise idea	1	2	3	4	5
	ATT3	Using Electronic Flight Strips is a pleasant trend	1	2	3	4	5
BI	BI	I presently wish to use the Electronic Flight Strip System regularly at work	1	2	3	4	5

Note: Scale definitions are as follows. SD-Strongly Disagree, D-Disagree, N-Neither Agree nor Disagree, A-Agree, SA-Strongly Agree

Appendix D.**Table (iv).** Descriptive statistics for Scale Items

Item	<i>M</i>	<i>SD</i>	Mode	S.D.	D.	N.	A.	S. A.	Scale	Scale %
PU1	3.71	1.09	4	3	4	7	24	10	Agree	50
PU2	4.02	1.06	4	2	3	5	20	18	Agree	41.7
PU3	3.44	.99	4	2	5	17	18	6	Agree	37.5
PU4	3.96	1.03	4	2	2	8	20	16	Agree	41.7
PEOU1	4.04	.74	4	1	0	6	30	11	Agree	62.5
PEOU2	4.04	.97	4	2	2	3	26	15	Agree	54.2
PEOU3	4.15	.94	5	1	2	6	19	20	S. A.	39.6
PEOU4	3.96	.87	4	0	3	10	21	14	Agree	43.8
T1	4.02	.84	4	0	4	4	27	13	Agree	56.3
T2	3.52	.94	4	1	6	14	21	6	Agree	43.8
ATT1	4.08	1.01	4	2	2	4	22	18	Agree	45.8
ATT2	3.90	1.12	4	3	2	8	19	16	Agree	39.6
ATT3	4.00	.90	4	1	2	7	24	14	Agree	50
BI	3.96	1.07	4	3	2	4	24	15	Agree	50

Note: Scale definitions are as follows. SD-Strongly Disagree, D-Disagree, N-Neither Agree nor Disagree, A-Agree, SA-Strongly Agree

Appendix E.**Table (v).** Descriptive Statistics and Pearson Correlations for Study Variables

Variables	<i>n</i>	<i>M</i>	<i>SD</i>	1	2	3	4	5
PU	43	3.96	0.67	-				
PEOU	43	4.19	0.53	.64**	-			
ATT	43	4.23	0.57	.56**	.56**	-		
T	43	3.87	0.72	.47**	.51**	.45**	-	
BI	43	4.26	0.62	.60**	.61**	.59**	.50**	-

** $p < .01$