Efficiency Of Analog And Digital Aircraft Instrument System In Cessna 172

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Abstract: - Nowadays, aviation industries use both analog and digital technology on Cessna planes. With the continuous improvement of these types of planes, the greater the importance to study the efficiency of analog and digital aircraft instrument system in cessna 172. Well-established Approved Training Organization train aviation pilots using the latest technically advanced aircraft (TAA). Most believe that the advanced avionic displays, autopilots, and moving maps, which emulate larger commercial aircraft flight decks, are required to give new student pilots a training advantage. Workload, situational awareness, and systems management and integration of these elements will all be enhanced by using TAA. In this research, the researchers analyze and evaluate the Efficiency between Analog and Digital Aircraft Instrument System in Cessna 172 in OMNI Aviation Corporation to determine if there is a significant difference between the utilization of analog and glass cockpit Cessna 172 planes.

Key Words:— ***Analog and Digital Aircraft, Cessna 172 Instrument System, Efficiency, Technology, Innovation.***

I. INTRODUCTION

In 1920's, flying an aircraft has been so difficult. The very first aircraft had little or no flight instrument. Flying especially during bad weather was too risky. Navigation on that time depends on the pilot's ability to use landmarks. That's why it's very hard to fly an aircraft in a dim environment. Another challenge faced by early aircrafts is when measuring the amount of fuel needed to travel or to monitor the safety as well as to calculate every important detail during flight. As time flies, many different kinds of plans were used. As pilots began flying at night and in all types of weather, new instrument were developed to enable the aircraft to fly. They are key to learning how to control the aircraft and an important part of pilot training (Matt 2017).

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Nowadays, aviation industries use both analog and digital technology on Cessna planes. With the continuous improvement of these types of planes, the greater the importance to study the efficiency of analog and digital aircraft instrument system in cessna 172. In line with this, to provide knowledge for the new pilots who will be using these technology for operating Cessna planes. It brings about thoughts on rapid progress of technology. The reason why the researchers chose this study is to find out why analog instrument system is still utilized, even when digital technology, which is more advance, has already been introduced.

There are many advantages to train new pilots using the technically advanced aircraft (TAA). Most believe that the advanced avionic displays, autopilots, and moving maps, which emulate larger commercial aircraft flight decks, are required to give new student pilots a training advantage. Workload, situational awareness, and systems management and integration of these elements will all be enhanced by using TAA. Aircraft were once only equipped with analog instrumentation. Today's general aviation flight schools may have a variety of new generation, digital instrumentation and pilots take their first lesson in digitally equipped aircraft.

Once a pilot earns a flight certificate, regardless of whether or not the training aircraft used digital or analog instrumentation, there is no regulation requiring any type of transition training between the different types of instrumentation. Lack of instrumentation display formalization and layout may lead to impaired skills and decreased situational awareness (Whitehurst Brothers, 2011).

For this study, the researchers analyze and evaluate the Efficiency between Analog and Digital Aircraft Instrument System in Cessna 172 in OMNI Aviation Corporation to determine if there is a significant difference between the utilization of analog and glass cockpit Cessna 172 planes.

II. Literature Review

Most of instruments and, in particular, flight instruments, are mechanical and analogue, typically operated by air pressure and the use of gyroscopes without the need of any electrical system. There is little or no functional aggregation, having one instrument per function. This typically results in a cognitive overload for the pilots, who must keep a continuous situational awareness. (Del Castillo & Couture 2016).[1]

The glass cockpit concept is nowadays well established in the flight industry, but according to Alm, it is almost unknown in the automotive business. The basic idea of the glass cockpit concept is to replace static controls and instruments with glass displays and by doing so creating an updatable and mode based driving environment that adjusts the display information when needed.[2]

In the field of aviation this has simplified the cockpit environment enormously and has allowed the pilots to focus on the most essential information. Today, the glass cockpit is standard equipment in airliners, business jets and military aircraft. Even basic aircraft like the Piper Cherokee, PA 31 and Cessna172 can be delivered with glass cockpits. This is something that has revolutionized the aviation field and is highly appreciated among pilots and aircraft companies. (Spendel & Strömberg 2009).[3]

Andrew Murray (2017) with his study of "Analog Dials vs Digital Screens" said that there is no doubt that the technology that has powered the airliners for years have now entered the general aviation scene. The glass cockpits have also crept their way into the training school where brand new students begin flying on aircraft fitted with technically enhanced cockpits. This offers the general aviation with a wide range of new problems that are associated with the introduction of glass cockpits. The smaller aircraft will not be able to sustain the glass screen for long if there is a power failure. This means that the pilots have limited time when something goes wrong. Though there is less accident, the ones that are happening are more likely to be fatal. A recent NSTB review found that the pilot was spending more time learning the glass cockpit during training and less on the actual flying skill and this can be fatal if the systems fail. The systems can provide excellent situational awareness, this can only happen when the pilot knows how to use them without having to think about it. The more time spent trying to select the correct function, the less time and concentration that can be used on flying the aircraft. The biggest advantage to a glass cockpit over traditional cockpits is that the automation systems are more accurate, the information is more precise, and the data is displayed more ergonomically. Glass cockpits also include feedback loops and the capability for self-checking to alert the pilot to problems before they become emergencies.[4]

III. Methods And Procedures

3.1 Methods of Research

This study aimed to distinguish between the Efficiency of Analog and Digital Aircraft Instrument System in Cessna 172. The methodology used is primarily quantitative-descriptive.

3.2 Respondents of the Study

The vicinity of the study was at Omni Aviation Corporation, an aviation company which is based in Clark field, Angeles City, Pampanga. Twenty flight instructors/ground instructors which are the main respondents of the study.

3.3 Data Gathering Instruments

The researchers administered questionnaires using the Likert five -point scale as the data gathering device. The survey questionnaire consists of three parts, Part 1 dealing with the profile of the respondents and Part II dealing with specific questions concerning the difference between the use of analog and digital technology in Cessna planes and Part III includes safety measures and precautionary measures in using both technologies. The five-point likert scale consist of 5 tables which is to be answered by the respondents based on their answer on the survey questionnaire consisting Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. The five-point likert scale was approved by the registered statistician whom the researchers consulted.

3.4 Statistical Treatment of Data

The data to be gathered from the questionnaire will be tabulated and appropriate frequency table constructed. For the most valid computation and interpretation of data, a licensed SPSS version 25 was used. The following descriptive statistics was used to analyze the data obtained.[4]

- Frequency Distribution. The data gather will be tallied and tabulate to indicate the number of respondents to a specific question in the questionnaire.
- The percentage will determine from the frequency of the respondents or perceived/perceptual assessment of the respondents.

The formula is:
P= x 100

Where:

P - Percentage (%)
f - Frequency (number of respondents)
n - The total population

- Mean. The mean will be used to get the average score of the responses of the respondents regarding the difference between the use of analog and digital technology of Cessna 172.
- To determine the significant difference between the use of analog (steam gauge) or digital (glass cockpit) T-test of correlation will be used.

The researcher personally administered to the respondents the questionnaires and explained the purpose of the instrument. The data were tallied and tabulated. A five-point likert scale was used to describe the attitudes of the respondents towards physics. [5]

Scale	Description
4.50 – 5.00	Strongly Agree
3.50 – 4.49	Agree
2.50 – 3.49	Neutral
1.50 – 2.49	Disagree
1.00 - 1.49	Strongly Disagree

IV. RESULTS AND DISCUSSION

This chapter presents the various data gathered, analysis and interpretation of results.

I. Profile of the Respondents

Table 1. Distribution of the respondents according to sex

Sex	Frequency	Percentage
Male	18	90%
Female	2	10%

Out of twenty (20) respondents, 18 or 90% were male and 2 or 10% were female. As the data shows, the respondents are dominated by male pilots (Table 1.)

Table 2. Distribution of the respondents according to age

Age	Frequency	Percentage
21-25	8	40%
26-30	6	30%
31-34	6	30%
35-above	0	0%

In terms of respondent's age, participants whose age ranging from 21-25 were 18 or 40% who dominated the other. On the other hand, those participants ranging from 26-30 and 31-34 were the same 30%. However no participants aged 35 and above. This indicates that the respondents are young and not too old as that(Table 2).

III. Efficiency between Analog, Digital and Both Technology in Cessna 172 in terms of Maneuvering

Table 3. Mean Difference in the Utilization of Analog, Digital and Both Technology in Cessna 172 in Terms of Maneuvering

Maneuvering	Mean	Description
1. I prefer to use digital instruments when it comes in maneuvering.	3.40	Neutral
2. I prefer to use analog instruments when it comes in maneuvering.	3.65	Agree
3. Digital Instruments are easy to monitor when maneuvering or controlling the aircraft.	3.90	Agree
4. Analog instruments are easy to monitor when maneuvering or controlling the aircraft.	3.20	Neutral

5. Using a combination of analog and digital instrumentation makes it easier to maneuver an aircraft.	4.40	Agree

Legend:
4.50 – 5.00 - Strongly Agree
3.50 – 4.49 - Agree
2.50 – 3.49 - Neutral
1.50 – 2.49 - Disagree
1.00 – 1.49 - Strongly Disagree

The result showed the mean comparison in the Efficiency of Analog, Digital and Both Technology in Cessna 172 in terms of maneuvering. The data presented revealed that respondents preferred to use analog against digital, with the mean of 3.65 and 3.40 respectively. The respondents agreed (3.65) that analog instruments are preferable than digital instruments against responses (3.40) who are neutral. On the other hand, in terms of monitoring when maneuvering, the mean obtained were 3.90 and 3.20 which revealed that digital (3.90) is preferable than analog (3.20). The equivalent obtained mean of 3.90 is Agree for digital and 3.20 which is neutral for the analog. However, the difference of the mean computed do not shows high difference which means that the obtained mean of 4.4, that has a description of Agree revealed that the combination of the use of analog and digital makes efficient and easier in terms of maneuvering. (Table 3).

One of the respondents said that although he was more trained in analog instrument and he is comfortable in flying analog, digital instrument flying makes monitoring and controlling the aircraft easier.

IV. Efficiency between Analog, Digital and Both Technology in Cessna 172 in terms of Accuracy

I.

Table 4. Mean Comparison Utilization of Analog, Digital and Both Technology in Cessna 172 in terms of Accuracy.

Accuracy	Mean	Description
1. Digital instrumentation gives an accurate reading when it comes in transmitting information.	4.3	Agree
2. Analog instrumentation gives an accurate reading when it comes in transmitting information.	3.2	Neutral
3. Digital instrumentation is accurately suitable for beginner pilot.	2.65	Neutral
4. Analog instrumentation is accurately suitable for beginner pilot.	4.2	Agree
5.Both types of instrumentation will perfectly give an accurate info.	3.6	Agree

Legend:
4.50 – 5.00 - Strongly Agree
3.50 – 4.49 - Agree
2.50 – 3.49 - Neutral
1.50 – 2.49 - Disagree
1.00 – 1.49 - Strongly Disagree

The computed mean in item 1 and 2, 4.3 (Agree) and 3.2 (Neutral) respectively shows that digital instrumentation gives a more accurate reading when it comes to transmitting information. In item 3 and 4, with the obtained mean of 2.65 (Neutral) and 4.2 (Agree) suitable for beginner pilot. But considering both instrumentation in operation of Cessna 172 is recommended based from the obtained mean of 3.60 which has a descriptive of Agree (Table 4).

V. Efficiency between Analog, Digital and Both Technology in Cessna 172 in terms of Navigation

Table 5. Mean Comparison Utilization of Analog, Digital and Both Technology in Cessna 172 in terms of Navigation

Navigation	Mean	Description
1. Analog instrumentation is easier to use in terms of navigating the aircraft.	2.95	Neutral
2. Digital instrumentation is easier to use in terms of navigating the aircraft.	4.3	Agree
3. Analog instrumentation performs better when navigating an aircraft.	2.85	Agree
4.Digital instrumentation performs better when navigating an aircraft.	4.35	Agree
5.Combination of both analog and digital instruments performs better in navigating an aircraft.	3.9	Agree

Legend:
4.50 – 5.00 - Strongly Agree
3.50 – 4.49 - Agree
2.50 – 3.49 - Neutral
1.50 – 2.49 - Disagree
1.00 – 1.49 - Strongly Disagree

From the calculated mean in item 1 and 2, 2.95 (Neutral) and 4.3 (Agree) respectively revealed that digital instrumentations are recommended to use in Cessna 172 in terms of navigation easier.

Likewise, in item 3 and 4 with the computed mean of 2.85 (Neutral) and 4.35 (Agree) pertains that digital instrumentation were also recommended to utilize in the operation of Cessna 172 in terms of better navigation. The computed mean of 3.9 (Agree) signifies the efficiency of both technology in navigation makes easier and better. (Table 5).

Based on one of the flight instructors, using digital instrumentation such as Honeywell greatly improves navigational accuracy although analog gives more situational awareness.

VI. Efficiency between Analog, Digital and Both Technology in Cessna 172 in terms of Safety

Table 6. Mean Comparison Utilization of Analog, Digital and Both Technology in Cessna 172 in terms of Safety

Safety	Mean	Description
1. Analog is much safer than the digital instrumentation on aircraft cockpit.	3.00	Neutral
2. Digital is much safer than the analog instrumentation on aircraft cockpit	3.65	Agree
3. Analog instrumentation is much prone to malfunction than digital instrumentation.	3.35	Neutral
4. Digital instrumentation is much prone to malfunction than analog instrumentation?	3.10	Neutral
5. Combination of analog and digital instrumentation is much safer to use.	4.35	Agree

Legend:
4.50 – 5.00 - Strongly Agree
3.50 – 4.49 - Agree
2.50 – 3.49 - Neutral
1.50 – 2.49 - Disagree
1.00 – 1.49 - Strongly Disagree

The results pertains that digital technology is safer to use in operation of Cessna 172 from the computed mean 3.00 (Neutral) and 3.65 (Agree) as basis in favor of digital technology. On other hand, there is just a slight difference between item 3 and 4 with the computed mean of 3.35 and 3.10 respectively when it comes to being prone to malfunctioning. . Both mean falls under a description of Neutral, that indicates that both technology are either or both prone to malfunctioning. But from the responses of the respondents revealed from the obtained mean of 4.35 which revealed that both Technology are prone (Agree) to malfunctioning. Although the slight difference indicates that analog are prone to malfunction compare to digital. (Table 6) One of the ground instructor thought that both forms have their pros and cons. The combination of both will help maintain backup in case of failures

VII. Efficiency between Analog, Digital and Both Technology in Cessna 172 in terms of Efficiency

Table 7. Mean Comparison Utilization of Analog, Digital and Both Technology in Cessna 172 in terms of Efficiency.

Efficiency	Mean	Descriptive
1. Digital is more efficient than the analog instrumentation in terms of checking fuel consumption.	4.0	Agree
2. Analog is more efficient than the digital instrumentation in terms of checking fuel consumption.	2.8	Neutral
3. Analog instrumentation is more efficient in giving a warning signal to the pilot.	4.15	Agree
4. Digital instrumentation is more efficient in giving a warning signal to the pilot.	2.9	Neutral
5. Combination of analog and digital instrumentation is more efficient in flying an aircraft.	4.25	Agree

Legend:
4.50 – 5.00 - Strongly Agree
3.50 – 4.49 - Agree
2.50 – 3.49 - Neutral
1.50 – 2.49 - Disagree
1.00 – 1.49 - Strongly Disagree

The calculated mean in item 1 and 2 , 4.0 (Agree) and 2.8 (Neutral) respectively revealed that digital instrumentation is more efficient than analog instrumentation in terms of checking fuel consumption. Likewise the obtained mean in item 3 and 4, 4.15 (Agree) and 2.9 (Neutral) respectively indicates that digital instrumentation is more efficient, the computed mean in item 5, which is 4.25 (Agree) shows the both technology should be incorporated for the more efficient performance of Cessna 172. (Table 7)

One of the more experienced pilot said that “knowing analog indication will help support information provided by the digital instrument”.

VIII. Efficiency between Analog, Digital and Both Technology in Cessna 172 in terms of Maintenance

Table 8. Mean Comparison Utilization of Analog, Digital and Both Technology in Cessna 172 in terms of Maintenance

Maintenance	Mean	Description
1. Digital instrumentation is more expensive on maintenance cost.	4.20	Agree
2. Analog instrumentation is more expensive on maintenance cost.	2.75	Neutral
3.Analog instrumentation often needs calibration.	3.30	Neutral
4. Digital instrumentation often needs calibration.	4.15	Agree
5. Analog and digital instrumentation has no difference when it comes in maintenance.	2.40	Disagree

Legend:
4.50 – 5.00 - Strongly Agree
3.50 – 4.49 - Agree
2.50 – 3.49 - Neutral
1.50 – 2.49 - Disagree
1.00 – 1.49 - Strongly Disagree

The computed mean in item 1 and 2, 4.20 (Agree) and 2.75 (Neutral) respectively shows that digital instrumentation is more expensive on maintenance cost compare to digital instrumentation. Between item 3 and 4, with the obtained mean of 3.30 (Neutral) and 4.15 (Agree) respectively pertains that digital instrumentation often needs calibration than analog instrumentation. However, in item 5 the computed mean of 2.4 that says analog and digital instrumentation has no difference when it comes to maintenance, respondents disagreed. (Table 8).

Table 9. Comparison between analog and digital instrumentation

Descriptive Statistics				
	Mean	SD	t	Sig. 2-tailed
Analog	3.25	2.166673		
Digital	3.78	1.84330	-9.973	.000
Mean Difference	0.53			

The data shows that a difference of 0.53 in the mean between the utilization of analog (3.25) and digital (3.78) instrumentation. This indicates that digital instrumentation for Cessna plane is more preferable compare to that of the analog. The computed t value of -9.973 and the p value of 0.000 less than 0.01 level of significance. This means that there is a significance difference between the use of digital instrumentation and analog instrumentation in Cessna planes. (Table 9).

V. Conclusion And Recommendations

Conclusion:

The flight instructor/ground instructor respondents are 100% working in Omni Aviation Corporation. Among 20 respondents, 18 or 90% composed of male respondents and 2 or 10% are female respondents. The average age of flight instructor/ground instructor respondents is 27.

Analog instrumentations were preferable to use in terms of maneuvering compare to digital instrumentations because of its efficiency and easy monitoring. But maneuvering is more easy and efficient if both analog and digital instrumentation will be utilized.

- In terms of accuracy, digital instrumentations were more accurate compare to analog instrumentations. However, analog instrumentation was accurately suitable for beginner pilot. It was found out that both technologies are highly preferable for more accurate operations of Cessna 172.

- When it comes to safety, digital instrumentations were safer compare to analog instrumentations, but analog technology were prone to malfunctioning. The results also revealed that combination of analog and digital instrumentations is much safer to use.

- Regarding efficiency, it was found out that digital instrumentation were more efficient in terms of checking fuel consumption and giving warning signals to pilots compare to that of analog instrumentation. However, results revealed that the utilization of both technologies is highly recommended.

- Maintenance between digital instrumentation and analog instrumentation showed a high difference. It was revealed that digital instrumentation was more expensive on maintenance cost compare to analog instrumentation.

Reccomendations:

Based on the results of the study, the following recommendations should be considered:

- Aviation companies should consider the use of both analog and digital instrumentation in operations not only for Cessna planes but other air-based transportation technology.

- Institution offering aviation courses including the institution where the researchers are affiliated, should take into considerations the incorporation of the

results of this study to curriculum developers to address needs for more development.

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