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Research Article

Analyzing the New Global Reporting Format from the Pilot Perspective

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Abstract

Global Reporting Format (GRF) for runway surface conditions is an important step in improving aviation safety by providing standardized and consistent information. The aim of the study was to evaluate the effectiveness and implementation of the GRF among pilots. Qualitative and quantitative methods were used to comprehensively address all aspects of the study. The sample consisted of 266 pilots. Findings showed that the majority of pilots are aware of the GRF and value its benefits, such as consistency, reliability, and standardized terminology, despite it being a new method. Pilots highlighted the role of the GRF in improving communication and decision-making for take-off and landing. However, the study also identified challenges, including occasional inaccuracies in reporting, the need for real-time updates, the length of ATIS reports, and inconsistencies in application across airports in different regions. These issues highlight the human factor and the need to develop the GRF. The study makes a unique contribution by highlighting both the practical benefits and the challenges of the GRF from the perspective of the pilots. It is recommended that future research include a more diverse sample of pilots from all regions and that technical studies be undertaken to compare runway surface conditions with aircraft performance under the GRF. This will provide a more complete understanding of the effectiveness of the GRF and identify areas for further improvement.

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1. Introduction

Runway excursions stand out as the highest risk category, highlighting the critical importance of runway safety, especially in the field of aviation safety (Kornstaedt, 2019). According to global estimates, the aviation industry incurs an average of $500 million per month in costs due to runway-related accidents and incidents (Van Eekeren et al., 2018). Between 2013 and 2022, a total of 125 runway excursion accidents were recorded. Notably, there were no runway excursion accidents in the year 2021, in contrast to the seven runway excursion accidents that occurred in the year 2022. It is important to note that the runway excursion accident rate in 2022, at 0.22, was lower than the 5-year average (2018-2022) runway excursion accident rate, which was calculated at 0.27 per million sectors. Of the 125 runway excursion accidents, 98 were related to passenger flights, and the remaining 27 were related to cargo flights (International Air Transport Association [IATA], 2023). In the initial reports for the year 2023,

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runway excursion incidents accounted for the highest number of accidents and serious incidents (European Union Aviation Safety Agency [EASA], 2024). Furthermore, according to the 2023 edition of the Statistical Analysis of Commercial Aircraft Accidents 1958-2023 by Airbus (2024), a significant portion, nearly 60%, of fatal accidents and hull losses occurred during the landing phase. In addition, runway excursion incidents ranked as the third most important factor in fatal accidents (18%) and the most critical factor in hull losses (36%) between 2003 and 2023 (Airbus, 2024). Therefore, it is essential to carefully monitor and assess runway conditions to mitigate the associated risks.

Based on runway excursion accident/incident reports, it is generally recognized that several factors are involved. Some studies identified factors such as runway and touchdown zone characteristics, flight control during approach, aircraft malfunction, weather factors, and runway surface and braking conditions (Garcia et al., 2023). Weather factors were identified as a contributing factor to runway excursions (Distefano and Leonardi, 2019; Maeng et al., 2012). Specifically, weather conditions such as wet or flooded runways, rain, and thunderstorms were found to increase the risk of runway excursions (Chang et al., 2016; Karyawan, 2021).

The risk of runway excursions can be increased during wet weather conditions, mainly due to the accumulation of water on the runway surface (Pasindu et al., 2016). It was emphasized that the effect of accumulated water on runway friction and aircraft braking ability, which can contribute to excursions, can potentially lead to loss of control during landing or take-off (Brassard et al., 2019; Klein-Paste, 2018; Kornstaedt and Lignee, 2010; Niu et al., 2021; Procházka and Kameník, 2013). In addition, pilots identified wet or containment runways and weather issues as important risk factors for runway excursions (Brassard et al., 2022; Chang et al., 2016; Distefano and Leonardi, 2019).

The reporting, assessment, and accuracy of runway surface conditions for contaminated runways can pose risks to braking performance and overall runway safety (Brassard et al., 2022; Sama et al., 2022). Poor runway braking performance is a significant factor in runway excursions (Hu et al., 2022).

International Civil Aviation Organization (ICAO) introduced a new Global Reporting Format (GRF) for runway surface conditions based on human observers on 4 November 2021. The purpose of the GRF is to improve runway safety and minimize the risks associated with poor braking performance, as well as to provide a standardized method for reporting and assessing runway surface conditions worldwide. By providing a consistent and accurate description of runway surface conditions, the GRF helps flight crews make informed decisions during take-off and landing, especially in adverse weather conditions (Brassard et al., 2022; Chen et al., 2022; ICAO, 2021; Tuncal et al., 2021).

The previous method of reporting runway surface conditions showed significant variation between regions and airports, potentially causing confusion and inconsistencies for pilots. The lack of a standardized method for reporting runway surface conditions made it difficult for pilots to make informed decisions during take-off and landing, particularly in adverse weather conditions. In addition, many safety incidents were attributed to runway surface conditions, and investigations revealed deficiencies in the accuracy and timeliness of assessment and reporting methods outlined in ICAO regulations and guidance material (Kornstaedt, 2019).

The GRF is based on objective criteria to reduce subjectivity and promote consistency in the assessment of runway surface conditions. The integration of standardized terminology and runway condition codes serves to increase the accuracy and consistency of reported data. The Runway Condition Assessment Matrix (RCAM), as shown in Table 1, plays a key role in providing a consistent method for assessing runway conditions, taking into account factors such as surface type, contaminants, depth, and coverage. The RCAM, as defined by ICAO, categorizes runway conditions on a scale from 6 (dry) to 0 (the worst conditions, including wet ice and snow on ice). This classification enables pilots to assess the expected braking performance in different weather and runway conditions, providing vital information for safe landing and take-off. This standardized approach not only improves safety but also facilitates more efficient and effective airport operations by providing pilots with accurate information (Bylica and Pashkevich, 2022; Vorobyeva et al., 2020).

Based on observations linked to RCAM, a Runway Condition Report (RCR) is generated. RCR includes mandatory aircraft performance assessments and an optional situational awareness section, integrating operational details for taxiways and aprons, as shown in Figure 1. RCR is disseminated via ATIS (Automatic Terminal Information Service) and/or SNOWTAM.

The GRF outlines information on runway surface conditions to be provided to the pilot, in particular with regard to aircraft performance, and requires manufacturers to provide performance data for the evaluation of the pilot, particularly on winter-contaminated runways (ICAO, 2020). The relationship between the landing distance factors (LDFs) and runway condition code (RWYCC) based on the landing performance data and related procedures determined for the existing conditions during landing for turbojets and turboprops is presented in Table 2.

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GG EADBZQZX EADNZQZX EADSZQZX
170229 EADDYNYX
SWEA0151 EADD 02170225
(SNOWTAM 0151
EADD
02170055 09L 5/5/5 100/100/100 NR/NR/03 WET/WET/WET SNOW
02170135 09R 5/2/2 100/50/75 NR/06/06 WET/SLUSH/SLUSH
02170225 09C 2/3/3 75/100/100 06/12/12 SLUSH/WET SNOW/WET SNOW

RWY 09L SNOW BANK R20 FM CL. RWY 09R ADJ SNOW BANKS. TWY B POOR. APRON NORTH POOR)
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Fig. 1. RCR example (ICAO, 2018, p. APP 4-11)

Table 1. The Runway Condition Assessment Matrix (RCAM) (ICAO, 2019)

Runway Condition Code	Runway Condition Description	Pilot- Reported Braking Action
6	Dry	No action required
5	Frost Wet (The runway surface is covered by any visible dampness or water up to and including 3 mm depth) Slush (Up to and including 3 mm depth) Dry Snow (Up to and including 3 mm depth) Wet Snow (Up to and including 3 mm depth)	Good
4	Compacted Snow (15°C and lower outside air temperature)	Good to Medium
3	Wet ("Slippery Wet" Runway) Dry Snow or Wet Snow (any depth) on top of Compacted Snow Dry Snow (More than 3 mm depth) Wet Snow (More than 3 mm depth) Compacted Snow (Higher than -15°C outside air temperature)	Medium
2	Standing Water (More than 3 mm depth of water or slush) Slush (More than 3 mm depth of water or slush)	Medium to Poor
1	Ice	Poor
0	Wet Ice Water on top of Compacted Snow Dry Snow or Wet Snow on top of Ice	Less than poor

Table 2. Landing distance factors (ICAO, 2020)

RWYCC	6	5	4	3	2	1
Turbojet, no reverse	1.67	2.6	2.8	3.2	4.0	5.1
Turbojet, with reverse	1.67	2.2	2.3	2.5	2.9	3.4
Turboprop	1.67	2.0	2.2	2.4	2.7	2.9

Pilots are integral to the success of the GRF for runway surface conditions in several critical ways. They play a key role in receiving and understanding GRF reports and use standardized data to inform their take-off and landing decisions, communicating this information to Air Traffic Control (ATC) units such as Tower and Approach Control to ensure coordinated operations via reports, particularly in adverse weather conditions. Pilots also contribute to the accuracy of the reports by providing first-hand feedback on runway conditions, thus ensuring the accuracy of the information presented in the GRF. The observed braking capability and lateral control are dependent on a number of factors, including the aircraft type, weight, and the specific runway segment utilized for braking. Pilots are required to classify these conditions using a set of standardized terms, which are as follows: GOOD, GOOD TO MEDIUM, MEDIUM, MEDIUM TO POOR, POOR, and LESS THAN POOR (ICAO, 2019). This data is essential for flight planning, as pilots rely on standardized terminology and runway condition codes to make informed decisions about aircraft performance, braking, and landing distances, especially in challenging weather conditions. In addition, pilots provide essential feedback on the effectiveness of the GRF in improving the accuracy and consistency of runway surface condition reporting, contributing to continuous improvement and ensuring aviation safety.

Therefore, evaluations based on the pilots' experience with the GRF are crucial. This valuable feedback allows the new method to be continually improved, potential problems to be identified, and improvements to be made in problem areas. The information shared by pilots helps the aviation industry provide more accurate and consistent reports, ultimately improving aviation safety.

This pilot input will improve the effectiveness of the GRF. It will ensure safer aviation operations in the future.

The aim of the study is to examine pilot feedback on the GRF and to highlight its crucial role in the continuous improvement of this new approach. By examining how pilot experience helps to identify potential problems and implement necessary improvements, the research aims to highlight its essential role in advancing aviation safety. Ultimately, the aim is to clarify how pilot input enhances the effectiveness of the GRF, ensuring that future aviation operations are conducted with even greater safety and precision.

2. Method

The survey-based research approach was used as the most suitable method for the study. Survey-based data collection is an efficient method for gathering insights from large and diverse samples in academic research (Blondel et al., 2006; Kelley et al., 2003; Schoenherr et al., 2015).

2.1 Data collection process and instrument

A survey was conducted online between March and June 2024, with 266 pilots participating. The survey was divided into three sections: demographic information, questions about the reporting of runway surface conditions, and evaluations of the GRF. The third section of the survey used a 5-point Likert scale ranging from "(1) Strongly Disagree" to "(5) Strongly Agree".

Participants were informed of the aims of the research and their consent was obtained on a voluntary basis. The survey was designed to ensure the protection of participants' personal information and confidentiality throughout the process. Ethical approval for the study was obtained from İstanbul Esenyurt University Ethics Committee with decision number 2024-02 on 05.03.2024.

2.2 Statistical analysis

Descriptive statistics, including frequency (n), percentage (%), mean, and standard deviation, were initially used in the study. Factor analysis was used to assess the validity of the survey and Cronbach's alpha test was used to assess its reliability. After confirming the normality assumption as specified by Tabachnick and Fidell (2019), independent samples t-test and one-way ANOVA (Analysis of Variance) were performed for group comparisons. These statistical analyses were carried out using IBM SPSS (Statistical Package for the Social Sciences) v27.

In addition, a qualitative methodology was used. Responses to the open-ended question about concerns related to the GRF were subjected to qualitative content analysis to identify underlying themes. Data from 26 pilots who responded to the open-ended question were analyzed. Each response was coded, with initial coding carried out independently by two researchers to ensure reliability. Any discrepancies were resolved through discussion. To enhance the validity of the findings, the final codes and themes identified were reviewed by an expert in aviation safety and reporting, and their feedback was incorporated into the analysis. The findings are presented in thematic sections, each supported by direct quotes from participants. Quotes are identified by a "p" followed by a number, with codes in brackets at the end of each statement. This comprehensive qualitative methodology provides a clear understanding of pilots' concerns with the GRF and offers valuable insights for improving its design and implementation.

3. Results

3.1 Demographic information

The demographic information of the pilots is presented in Table 3. The data provides insight into the age, gender, title, experience, type of operation, flight frequency, and region of the 266 pilots who participated in the study.

The majority of pilots were in the 35-44 age group, representing 38.3% (n=102) of the sample. The 25-34 age group represented 27.8% (n=74) of the sample, while the 45-54 age group represented 19.2% (n=51). The group aged 55 and over represented 8.3% (n=22) of the sample. The smallest group was that of pilots aged 18-24, with 6.4% (n=17) of the total sample. The sample was evenly split between captains and co-pilots, with each group comprising 50.0% (n=133) of the total number.

The distribution of experience among pilots was fairly balanced, with each category (less than 5 years, 5-10 years, and 11-20 years) representing 26.7% (n=71) of the sample. Pilots with more than 20 years of experience represented 19.9% (n=53) of the sample. The majority of pilots worked in the airline sector, representing 87.6% (n=233) of the sample. Other types of operations (including private, charter, military, training, etc.) accounted for 12.4% (n=33). The largest group of pilots, representing 39.8% (n=106) of the sample, were those who flew more than 20 flights per month. The next largest group, representing 30.1% (n=80) of the sample, were those who flew between 10 and 20 flights per month, with less than 10 flights per month. The majority of pilots, representing 73.7% (n=196) of the sample, flew primarily in Europe. The remaining 26.3% (n=70) of the sample consisted of pilots flying in other regions.

3.2 Runway surface conditions

The survey included a question asking if pilots had ever been involved in an incident or accident caused by runway surface conditions. The majority of pilots, 94.4%, indicated that they had not experienced such an incident. However, 5.6% of pilots stated that they had been involved in an incident or accident due to runway surface conditions.

Of those pilots who responded in the affirmative to the question of whether they had experienced an incident or accident, several factors were identified as contributing to these events, as shown in Table 4. The most frequently cited factor was "incorrect or incomplete runway surface information", cited by 30.95%. This highlights the critical need for accurate and comprehensive runway surface condition reports to ensure flight safety. Inadequate procedures were cited by 16.67% of pilots, indicating that procedural errors or omissions also play a significant role in such incidents. A further 14.29% of pilots cited "inconsistent runway surface condition reports with aircraft performance" as a factor, indicating the importance of matching runway condition reports with actual aircraft performance data. In addition, 14.29% of pilots cited unexpected or sudden changes in weather conditions, highlighting the unpredictable nature of weather and its impact on runway safety. A further 11.90% of pilots stated that aircraft malfunctions or technical problems were a contributing factor. This suggests that mechanical problems can compound the challenges posed by adverse runway conditions. Non-standard terminology was cited by 9.52% of pilots, indicating that unclear or inconsistent language in reports can lead to misunderstandings and safety risks. Finally, fatigue was cited by 2.38% of pilots, highlighting the role of human factors in aviation safety.

The survey included questions on the frequency with which pilots encounter runway surface conditions that require reporting and the frequency with which they encounter conditions that are not accurately reported. The responses are summarized in Table 5 and Table 6.

Regarding the frequency with which they encounter reportable runway surface conditions, 54.9% of pilots indicated that this occurs rarely (less than 10% of the time). A further 34.6% of pilots reported that they sometimes encountered such conditions (between 10% and 50% of the time). A smaller percentage, 3.0%, reported that they often (more than 50% of the time) encounter conditions that require reporting. Only 7.5% reported that they had never encountered runway surface conditions requiring a report.

Table 3. Demographic info

		n	%
Age	18-24 years old	17	6.4
	25-34 years old	74	27.8
	35-44 years old	102	38.3
	45-54 years old	51	19.2
	55 years old or older	22	8.3
Title	Captain	133	50.0
	Co-pilot	133	50.0
Experience	< 5 years	71	26.7
	5-10 years	71	26.7
	11-20 years	71	26.7
	> 20 years	53	19.9
Operation type	Airline	233	87.6
	Other (Private. Charter. Military. Training etc.)	33	12.4
Flight frequency	Less than 10 flights	80	30.1
	10-20 flights	80	30.1
	More than 20 flights	106	39.8
Flight region	Europe	196	73.7
	Other	70	26.3
Total		266	100.0

Table 4. Factors involved in the accident or incident caused by runway surface conditions

Incorrect or incomplete runway surface information	%30.95
Inappropriate procedures	%16.67
Inconsistent runway surface conditions report with aircraft performance	%14.29
Unexpected or sudden changes in weather condition	%14.29
Aircraft malfunction or technical issue	%11.90
Non-standard terminology	%9.52
Fatigue	%2.38

Table 5. Encounter runway surface conditions that require reporting

	%
Never	7.5
Rarely (less than 10% of the time)	54.9
Sometimes (between 10% and 50% of the time)	34.6
Often (more than 50% of the time)	3.0

Table 6. Frequency of encountering inaccurately reported runway surface conditions

	%
Never	10.9
Seldom (less than 10% of the time)	71.1
Occasionally (between 10% and 50% of the time)	15.0
Frequently (more than 50% of the time)	3.0

Regarding the frequency of encountering inaccurate runway surface conditions, the majority of pilots, 71.1%, reported that this occurred rarely, less than 10% of the time. In addition, 15.0% of pilots reported that they sometimes encountered inaccurate reports, ranging from 10% to 50% of the time. Similar to the previous question, 3.0% of pilots indicated that they often (more than 50% of the time) encounter inaccurate reported conditions. A small proportion, 10.9%, stated that they had never encountered inaccurately reported runway surface conditions

3.3 Global reporting format (GRF) perspective

Awareness

The survey included a question asking whether pilots had heard of the new GRF for assessing runway surface conditions. The majority of pilots, 79.7%, said they had heard of the new GRF. However, 20.3% of pilots said they had not heard of it.

Of those who responded in the affirmative to the question of whether they had heard of the new GRF, several sources were cited as the means by which they became aware of the format, as shown in Table 7. The most commonly cited source was “company training/notification”, cited by 54.85% of pilots. This underlines the crucial role of organizational training and communication in disseminating important updates such as the GRF.

Online resources or publications were cited by 17.09% of pilots, indicating that digital materials also play an important role in raising awareness. Discussions with colleagues or aviation professionals were cited by 11.73% of pilots, highlighting the importance of peer communication in spreading knowledge about the GRF.

A notice or circular issued by the Civil Aviation Authority (CAA) or Air Navigation Service Provider (ANSP) was mentioned by 8.93% of pilots, indicating the role of official communication in informing pilots. Finally, 7.40% of pilots indicated that research or personal interest was a source of awareness, suggesting that individual initiatives also contribute to understanding new reporting formats.

Factor analysis of the survey items developed to assess pilot GRF revealed a KMO (Kaiser–Meyer–Olkin) of 0.886 (>0.50), Bartlett's sphericity test with a p-value of 0.000 ($\chi 2=959.775$; df:15; $p<0.001$), and a single-factor explained variance of 68.503% (>60%). The inter-item correlation values ranged from 0.514 to 0.707 (>0.30), the factor loadings were between 0.624 and 0.719 (>0.32), and the Cronbach's alpha value was 0.907 (>0.50), all of which are considered acceptable levels (Büyüköztürk, 2020; George and Mallery, 2003; Hair et al., 2019; Tabachnick and Fidell, 2019).

The evaluation of the GRF revealed some key aspects regarding its effectiveness and reception among pilots, as shown in Table 8. The mean scores and standard deviations provide a comprehensive understanding of pilots' perceptions. Firstly, pilots found the GRF to provide a consistent and reliable assessment of runway surface conditions, with a mean score of 4.06 and a standard deviation of 0.740, indicating relatively low variability in responses and broad agreement among pilots. Secondly, the GRF was appreciated for its standardized terminology across airports and regions, as evidenced by the highest mean score of 4.23 and a standard deviation of 0.789. This high score demonstrates the importance of consistent language in ensuring clear communication, with responses showing a strong consensus among pilots. In terms of providing detailed and accurate information for take-off and landing decision-making, the GRF achieved a mean score of 4.09 and a standard deviation of 0.752. This indicates moderate variability in the responses, with a strong consensus on the effectiveness of the GRF in this regard. The ease of use and understanding of the GRF in all conditions received a mean score of 4.12 and a standard deviation of 0.897, indicating considerable agreement among pilots on this attribute. In terms of facilitating better communication between pilots, air traffic control, and airport operators, the GRF achieved a mean score of 4.16 and a standard deviation of 0.841. This reflects moderate variability and strong agreement on the role of the GRF in improving communication. Finally, the role of the GRF in reducing the risk of runway accidents and incidents caused by poor runway surface conditions was recognized with a mean score of 3.98 and a standard deviation of 0.805. Although slightly lower than the other scores, this still reflects a positive reception and indicates the contribution of the GRF to safety.

Table 9 shows the rating of the GRF based on the current job title, with a t-test used to assess the statistical significance of the results. The mean scores for captains and co-pilots were found to be almost identical, with captains scoring a mean of 4.1128 and co-pilots scoring a mean of 4.1003. The results of the t-test indicated that there was no significant difference between the two groups (t = .153, df = 264, p = .878).

Table 10 shows the GRF scores based on years of experience using one-way ANOVA. The groups had mean scores ranging from 4.0751 to 4.1289. The results of the ANOVA indicated that there were no significant differences between the different experience groups (F = .078, p = .972).

Table 11 shows the GRF scores based on the number of flights performed per month using one-way ANOVA. The mean scores for the groups ranged from 4.0042 to 4.1085. The ANOVA results indicated that there were no significant differences based on flight frequency (F = 1.856, p = .158).

Table 7. Source of GRF information

	%
Training/Notification provided by the company	54.85
Online resources or publications	17.09
Discussions with colleagues or aviation professionals	11.73
A notice or circular issued by the CAA or ANSP	8.93
Research or personal interest	7.40

Table 8. The mean score, standard deviation, skewness, and kurtosis of GRF survey

	Mean	Sd.	Skewness	Kurtosis
GRF provides consistent and reliable assessment of runway surface conditions.	4.06	.740	-.659	.880
GRF provides standardized terminology across all airports and regions.	4.23	.789	-.942	.887
GRF provides detailed and accurate information to take decisions about take-off and landing.	4.09	.752	-.579	.154
GRF is user-friendly and easy to understand in all conditions.	4.12	.897	-.895	.554
GRF enables better communication between pilots, air traffic control, and airport operators.	4.16	.841	-.958	.922
GRF reduces the risk of runway accidents and incidents caused by poor runway surface conditions.	3.98	.805	-.627	.364

Table 9. Evaluation of the GRF according to the current job title (t-test)

Groups	**n**	**Mean**	**Sd.**	**t**	**Df.**	**p**
Captain	133	4.1128	.64437	.153	264	.878
Co-pilot	133	4.1003	.68870			

Table 10. Evaluation of the GRF according to the experience (ANOVA)

Groups	**n**	**Mean**	**Sd.**	**F**	**p**	**Dif.**
< 5 years	71	4.0751	.60866	.078	.972	-
5-10 years	71	4.1150	.74140			
11-20 years	71	4.1127	.69281			
> 20 years	53	4.1289	.60944			

Table 11. Evaluation of the GRF according to the flight frequency per month (ANOVA)

Groups	**n**	**Mean**	**Sd.**	**F**	**p**	**Dif.**
Less than 10 flights	80	4.0042	.79731	1.856	.158	-
10-20 flights	80	4.2063	.55388			
More than 20 flights	106	4.1085	.62743			

Challenges and considerations in implementing the GRF

The following four themes emerged from the qualitative content analysis: (1) lack of clarity and training, (2) frequency and timeliness of updates, (3) specific operational concerns, and (4) international implementation issues.

Theme 1: Lack of clarity and training

Many pilots mentioned that the lack of standardization and clarity in the new GRF is a significant issue. Pilots noted that there are some problems and confusion in reporting via SNOWTAM and ATIS, particularly in relation to the measurement of pollution and braking efficiency (p90). It was highlighted that there is inconsistency between airports in how the format is applied, leading to misunderstandings and difficulties in interpretation (p62, p71). Pilots stated that this is particularly challenging when GRF parameters are not clearly described for take-off or landing performance tools (p61) and noted that the new format made the process more complex, with extended coding making it difficult to understand (p118, p115, p116). There is a call for regular and comprehensive training for all parties to adapt effectively to the new system (p153, p181, p126, p103).

Theme 2: Frequency and timeliness of updates

Several pilots emphasized the need for more frequent and timely updates, noting that updates should be more frequent to accurately reflect real-time runway conditions. Pilots mentioned that receiving old runway assessment reports can lead to discrepancies in actual conditions (p52, p149, p25) and said that airport operators sometimes use outdated observation parameters, which negatively affect performance calculations (p246).

Theme 3: Specific operational concerns

Pilots raised specific operational concerns related to the GRF, mentioning that the GRF format sometimes makes ATIS reports too long, especially for airports with multiple runways, and suggested simplified reporting methods such as terms like "valid for both runways" (p268, p223). It was noted that there is a need for greater confidence in the assessment methods used by airport operators, as there is a perceived lack of reliability in the current system (p113), and that some pilots prefer to use letters (e.g., good, medium) rather than numbers to describe runway conditions, as this is easier to understand (p18).

Theme 4: International implementation and adaptation

It was noted that global implementation of the GRF requires a universal approach, with pilots emphasizing that the format should be made universal across different regions, including North America and Asia (p88). Pilots said that some countries have not fully adhered to the new format (p90). It was suggested that the adaptation of company performance calculation tools to the GRF format should be enforced by airport operators to ensure consistency and reliability (p61).

4. Discussion

The findings of the study provide important insights into the perception and implementation challenges of the GRF among pilots. The majority of pilots who participated in the study are well aware of the GRF, indicating successful dissemination of information by aviation authorities and operators. Most pilots found the GRF useful, citing its consistency, reliability, and standardized terminology as key benefits. However, the study also identified several challenges that need to be addressed to improve the effectiveness of the GRF.

The majority of pilots encounter situations that require reporting, underlining the need for reliable reporting and assessment systems for runway surface conditions. The presence of occasional inaccuracies in these reports poses a serious risk to flight safety. The GRF was developed to address these challenges by standardizing the terminology and procedures for reporting runway conditions, thereby reducing the risks associated with inconsistent or inaccurate reporting. In addition, GRF values are directly related to aircraft braking performance, making accurate reporting essential for safe take-off and landing operations. This underlines the critical role of the GRF in improving aviation communications and safety.

The GRF was highly regarded for its role in providing consistent and reliable assessments of runway surface conditions. Pilots appreciated the standardized terminology used across airports and regions, which simplifies communication and reduces the risk of misunderstandings. The ability of the format to provide detailed and accurate information for take-off and landing decisions was another significant benefit. The GRF was also praised for its user-friendliness and its contribution to better communication between pilots, air traffic control, and airport operators. Overall, the role of the GRF in improving aviation safety by reducing the risk of runway accidents and incidents caused by poor runway surface conditions was well received.

However, it is important to note that the average score for the role of the GRF in reducing the risk of runway accidents and incidents was slightly lower than for the other aspects. This may be influenced by various factors identified in runway incidents and accidents, such as inappropriate procedures, unexpected weather changes, aircraft malfunctions, and fatigue, as highlighted by study participants. Additionally, issues like incorrect or incomplete runway surface information and non-standard terminology were also noted as contributing factors. The GRF aims to mitigate these risks by providing accurate and standardized information, which is critical to improving runway safety.

Despite the positive reception, the study highlighted several challenges to the implementation of the GRF. A key issue is the lack of standardization and clarity, particularly in the reporting of pollution and braking efficiency through SNOWTAM and ATIS. Inconsistencies in the application of the GRF at different airports lead to misunderstandings and difficulties in interpretation. To ensure effective adaptation to the new system, there is a clear need for comprehensive and regular training for all stakeholders.

The frequency and timeliness of updates was also a concern. Pilots emphasized the need for real-time updates to accurately reflect runway conditions, as out-of-date reports can lead to discrepancies and affect performance calculations. The importance of the lack of up-to-date runway conditions is further confirmed by Chang et al. (2016) in their research on risk factors associated with pilots in runway excursions. Specific operational concerns were also raised, such as the length of ATIS reports. The aircraft performance section of the GRF includes observation times, runway descriptions, runway codes, contamination percentage, depth, and type separately for each runway. This comprehensive reporting within the GRF contributes to the length of ATIS broadcasts, which include operational and critical meteorological information. Longer broadcasts can increase the workload in the cockpit.

Additionally, pilots expressed concerns about the perceived reliability of the assessment methods used by airport operators. Bylica and Pashkevich (2022) highlighted in their study that human factors are the main challenge in this regard. Currently, the GRF relies entirely on human observation and experience. To mitigate the risks associated with human factors in runway surface assessment, Pestana et al. (2021) presented an innovative approach using laser scanning equipment for automated runway inspection. Sama et al. (2022) developed a model that performs autonomous and automatic measurements using additional materials. Although the results obtained with this model are slightly different from those expected, the actual runway conditions are not significantly affected.

Global implementation of the GRF requires a more universal approach, in line with its original purpose. The pilots highlighted the importance of a consistent format across different regions, including North America and Asia. The lack of full compliance with the GRF in some countries is a challenge to its universal applicability. There is also a need for airport operators to align their performance calculation tools with the GRF format to ensure consistency and reliability.

5. Conclusions

The aim of the study was to evaluate the new GRF for runway surface conditions, which represents a significant step forward in improving aviation safety worldwide. The GRF provides a standardized method for reporting and assessing runway surface conditions to provide more accurate and consistent information that can help reduce the risk of accidents and incidents caused by poor runway conditions. Early feedback from pilots and stakeholders has been positive, suggesting that the GRF has the potential to significantly improve aviation safety in the future.

Comprehensive evaluations were carried out using both quantitative and qualitative analysis to ensure a thorough assessment. This dual approach is particularly noteworthy as it incorporates direct feedback from pilots, the primary users of this new reporting format. By grounding the findings in practical, real-world experience, the study enhances the reliability and relevance of its findings. Such a multi-faceted evaluation underlines the importance of the new methodology and its potential impact on improving aviation safety.

The study has several limitations. The sample consisted mainly of pilots operating in Europe, which may limit the generalizability of the findings to other regions. In addition, the study focused on pilots' attitudes and perceptions without including technical assessments of runway surface conditions and aircraft performance. Future research should address these limitations by including a more diverse sample of pilots from different regions. It is also recommended that technical studies be conducted comparing runway surface conditions with aircraft performance under the GRF. Such studies would provide a more complete understanding of the effectiveness of the GRF and identify areas for improvement in its implementation.

In conclusion, while the GRF has been well received and offers several benefits, addressing the challenges identified and conducting further research will be critical to realizing its full potential in improving runway safety and operational efficiency. Aviation safety is paramount and continuous improvement of systems such as the GRF is essential to ensure the highest standards of safety and performance in the aviation industry.

CRediT Author Statement

Arif Tuncal: Methodology, Investigation, Data curation, Visualization, Writing-Original Draft, Writing –Review and Editing, Formal Analysis. **Ufuk Erol**: Supervision, Conceptualization.

Nomenclature

ANOVA : Analysis of Variance
ANSP : Air Navigation Service Provider
ATIS : Automatic Terminal Information Service
CAA : Civil Aviation Authority
EASA : European Union Aviation Safety Agency
GRF : Global Reporting Format
IATA : International Air Transport Association
ICAO : International Civil Aviation Organization
RCAM : Runway Condition Assessment Matrix
RCR : Runway Condition Report
RWYCC : Runway Condition Code

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