

AI-Assisted Revision in Safety-Critical Translation: A Corpus-Based Analysis of Aviation Maintenance Instructions

المراجعة المدعومة بالذكاء الاصطناعي في ترجمة نصوص السلامة: دراسة تحليلية لنماذج من تعليمات

صيانة الطائرات

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Received: 12/03/2026

Accepted: 26/04/2026

Published: 31/05/2026

Abstract:

The integration of artificial intelligence (AI) into translation workflows is transforming professional translation practices, particularly in technical and safety-critical domains. This study examines the role of AI-assisted revision in improving error detection in machine-translated safety documentation. Using a specialized corpus of aviation maintenance instructions translated from English into French, the research compares two revision workflows: traditional human revision and AI-assisted revision. Translation errors in the machine translation output were analyzed using a structured error taxonomy covering terminology errors, meaning distortions, procedural sequence errors, numerical inaccuracies, and omissions. The results indicate that AI-assisted revision achieved a higher error detection rate than traditional human revision, particularly for terminology inconsistencies and numerical anomalies. However, the findings also confirm that human expertise remains essential for interpreting contextual meaning and identifying pragmatic ambiguities. The study highlights the potential of hybrid human-AI revision models as effective quality assurance mechanisms for safety-critical technical communication.

Keywords: Artificial Intelligence (AI), AI-assisted revision, safety-critical translation, error detection, translation quality assurance.

الملخص:

أحدث دمج تقنيات الذكاء الاصطناعي في العملية الترجمة تحولاً ملحوظاً في ممارسات الترجمة المهنية، حيث أصبحت أنظمة الترجمة الآلية تستخدم لإنتاج النصوص المترجمة ومراجعتها. ومع ذلك، تتطلب نصوص السلامة مثل الكتيبات التقنية وإرشادات السلامة الصناعية درجة عالية جداً من الدقة نظراً لمحتواها الحساس، فأى خطأ في الترجمة قد يؤدي إلى عواقب خطيرة.

تهدف هذه الدراسة إلى تحليل دور المراجعة المدعومة بالذكاء الاصطناعي في تحديد الأخطاء في الوثائق التقنية المترجمة

آليا. اعتمدت الدراسة على مدونة مقتسبة من تعليمات الصيانة في مجال الطيران، تمت ترجمتها من اللغة الإنجليزية إلى الفرنسية باستخدام نظام الترجمة الآلية، ثم مراجعتها وفق طريقتين مختلفتين: المراجعة البشرية التقليدية والمراجعة المدعومة بالذكاء الاصطناعي. أظهرت النتائج أن المراجعة المدعومة بالذكاء الاصطناعي حققت معدلا أعلى في تحديد الأخطاء مقارنة بالمراجعة البشرية التقليدية. ومع ذلك، تظل الخبرة البشرية ضرورية لفهم السياق وضمان دقة المعاني، مما يدعم اعتماد نماذج مراجعة هجينة تجمع بين الخبرة البشرية وأدوات الذكاء الاصطناعي لتحسين جودة الترجمة.

الكلمات المفتاحية : الذكاء الاصطناعي، المراجعة المدعومة بالذكاء الاصطناعي، ترجمة نصوص السلامة، تحديد الأخطاء، ضمان جودة الترجمة.

1. INTRODUCTION

Technological advancements in artificial intelligence have significantly transformed the field of translation. As a result, professional translators increasingly integrate AI technologies into their workflows through computer-assisted translation tools and machine translation engines (Kenny, 2022, p. 87).

Despite these advancements, machine-generated translations continue to present several limitations, particularly in specialized domains where precision and reliability are essential. Safety-critical documentation—such as technical manuals, maintenance procedures, medical instructions, and hazard warnings—requires extremely precise language because translation errors may have significant consequences, including operational failures or safety risks (O’Brien et al., 2020, p. 45).

Translation revision therefore remains an essential component of quality assurance in technical translation. Previous research has emphasized the importance of systematic revision procedures for ensuring translation quality. Revision involves the systematic comparison of the source text and the target text in order to identify and correct errors related to meaning, terminology, grammar, style, and structure (House, 2015, p. 64). In safety-critical contexts, revision plays an even more important role because even minor linguistic inaccuracies may lead to misunderstandings or unsafe actions.

Recent developments in AI technologies have introduced tools capable of assisting revisers during the revision process. AI-based systems can automatically analyze translated texts, detect linguistic inconsistencies, and highlight segments that may require further review. Such tools have the potential to enhance translation quality assurance by supporting human revisers in identifying problematic segments more efficiently (Garcia, 2023, p. 115).

However, the integration of AI into translation revision workflows raises important questions regarding its effectiveness and reliability. While AI systems are highly effective at detecting patterns and structural inconsistencies, they may struggle to interpret contextual meaning or pragmatic nuances. Consequently, their ability to identify critical errors in safety-related communication remains an important topic for research.

At the same time, the increasing adoption of machine translation technologies has introduced new workflows in which human translators interact with automated systems. Studies indicate that translators adopt machine translation with varying degrees of acceptance depending on factors such as usability, trust in technology, and professional norms (Cadwell et al., 2018, p. 310).

This study investigates the potential of AI-assisted revision workflows to enhance error detection in safety-critical translation. By comparing traditional human revision with AI-supported revision processes, the study evaluates how artificial intelligence can contribute to translation quality assurance in high-risk communication environments.

Using a corpus of aviation maintenance instructions translated from English into French, the study demonstrates how AI-assisted revision tools can improve the detection of terminology inconsistencies, numerical errors, and structural anomalies in machine-translated texts. At the same time, the results highlight the continuing importance of human expertise for interpreting contextual meaning and ensuring the clarity of safety instructions. By combining insights from translation studies and digital translation technologies, the study proposes a hybrid human–AI revision model that supports risk-aware quality assurance in safety-critical communication.

The study addresses the following research questions:

- How does AI-assisted revision compare with traditional human revision in detecting translation errors?
- What types of critical errors occur most frequently in AI-generated translations of safety texts?
- Can AI systems help identify high-risk linguistic structures in technical documentation?
- How can AI contribute to terminology control and quality assurance in safety communication?

By examining these questions, the study seeks to contribute to ongoing discussions regarding the role of artificial intelligence technologies in professional translation practice.

2. Literature Review

2.1 Machine Translation, Translation Quality and Revision

Machine translation research has expanded significantly with the development of neural machine translation (NMT) systems, which have considerably improved translation fluency compared with earlier statistical approaches (Toral & Sánchez-Cartagena, 2017). Despite these advances, scholars emphasize that fluency does not necessarily guarantee semantic accuracy, particularly in specialized domains where precise terminology and contextual interpretation are essential (Chatzikoumi, 2020, p. 148).

In technical domains, translation quality depends largely on terminological consistency and functional clarity. Technical documentation frequently includes procedural instructions, safety warnings, and standardized terminology that must remain consistent throughout the text to avoid operational misunderstandings.

Several scholars have argued that translation quality should be evaluated in relation to the communicative purpose of the text. In safety-critical documentation, the primary objective is not stylistic elegance but clarity, precision, and reliability in the transmission of operational information (Reiss & Vermeer, 2014, p. 89).

Evaluation of machine translation quality has traditionally relied on a combination of automated metrics and human assessment. One of the most widely used metrics is BLEU, which compares machine-generated translations with reference translations (Papineni et al., 2002, p. 313). However, automated metrics present important limitations when applied to specialized technical texts because they do not always capture semantic accuracy or contextual adequacy.

Recent research has therefore explored alternative approaches to machine translation evaluation, including usability-based assessments and quality estimation models that aim to predict translation quality without relying on reference translations (Specia et al., 2020, p. 5; Yang et al., 2021, p. 222). These approaches may support automated quality monitoring within professional translation workflows.

2.2 Translation Revision Models

Translation revision represents a crucial stage in professional translation workflows, particularly in technical and safety-critical domains where accuracy and reliability are essential. Revision generally involves the systematic comparison of the source text and the target text in order to identify and correct translation errors (House, 2015, p. 64).

Several revision models have been proposed in translation studies and professional practice. These models provide structured approaches to identifying translation errors while ensuring that the target text fulfills its communicative purpose.

Traditional revision models distinguish between **bilingual revision** and **monolingual revision**. Bilingual revision involves the direct comparison of the source text and the translated text, whereas monolingual revision focuses on improving the linguistic quality of the target text (Baker, 2018, p. 312). In professional practice, both approaches are often combined to ensure semantic accuracy as well as stylistic clarity.

Functionalist translation theory further emphasizes that translation quality should be evaluated according to the communicative purpose of the target text (Reiss & Vermeer, 2014, p. 92). In safety-critical documentation, this purpose typically involves providing clear operational instructions and preventing misunderstandings that could lead to accidents.

From this perspective, translation can also be understood as a process of managing communication risks. Risk-oriented approaches in translation studies suggest that translators must evaluate the potential consequences of translation errors and prioritize accuracy in high-risk segments (Pym, 2014, p. 152). Such segments often include safety warnings, emergency procedures, and technical specifications.

Recent developments in artificial intelligence have introduced tools capable of supporting translation revision processes. AI-assisted revision systems can automatically analyze translated texts and identify potential issues such as terminology inconsistencies or structural anomalies.

Research suggests that AI technologies can improve the efficiency of revision workflows by helping revisers detect problematic segments more rapidly (Kenny, 2022, p. 104). In addition, machine translation evaluation frameworks and quality estimation models can provide automated indicators of translation reliability (Specia et al., 2020, p. 7).

In the context of safety documentation, effective revision workflows typically combine several complementary approaches:

- bilingual comparison for accuracy verification
 - monolingual revision for readability and clarity
 - risk-based prioritization of critical segments
 - AI-assisted tools for automated error detection

This integrated approach enables revisers to ensure both linguistic accuracy and operational reliability, which are essential in technical safety communication.

2.3 AI in Translation Workflows

The development of neural machine translation systems has significantly improved the fluency and readability of machine-generated translations. These systems rely on deep learning architectures trained on large multilingual datasets to produce contextually appropriate translations (Bowker & Buitrago-Ciro, 2019, p. 52).

The integration of artificial intelligence into translation environments has introduced new possibilities for supporting translation and revision processes. AI-based tools can assist translators through functions such as terminology extraction, translation quality estimation, and automated error detection (Specia et al., 2020, p. 6).

Because machine translation systems may still generate semantic or terminological inaccuracies, their output typically requires post-editing or revision before being used in professional contexts.

Research has also examined the impact of machine translation on translator productivity and professional practices. Studies indicate that machine translation can increase productivity when combined with post-editing workflows (O'Brien, 2011, p. 203). However, the growing automation of translation processes may also transform the role of translators within digital production environments (Moorkens, 2020, p. 14).

Other research has focused on the usability of machine translation systems and their influence on translator workflows. User-interface design and interaction with translation tools can significantly affect post-editing efficiency and translator satisfaction (Moorkens & O'Brien, 2017, p. 304).

Recent studies also highlight the growing role of artificial intelligence in translation productivity and quality management. AI-based tools can assist in identifying potential translation errors and improving terminology consistency across large documentation projects (Garcia, 2023, p. 118; Zou & Huang, 2023, p. 9).

At the same time, scholars emphasize that human expertise remains essential for interpreting contextual meaning and ensuring the accuracy of specialized texts (Läubli et al., 2020, p. 6). Consequently, hybrid human–AI workflows are increasingly considered a promising approach to translation quality assurance.

2.4 AI-Assisted Revision and Post-Editing

Recent research has explored the use of artificial intelligence not only for translation generation but also for translation revision and quality assurance.

AI-assisted revision tools can analyze machine translation output and provide automated feedback to revisers. These systems may identify potential issues such as:

- terminology inconsistencies
- grammatical anomalies
- missing segments
- structural irregularities

Automated quality evaluation metrics such as BLEU and METEOR are frequently used to assess machine translation quality by comparing translated texts with reference translations (Papineni et al., 2002, p. 313; Banerjee & Lavie, 2005, p. 68).

However, automated metrics cannot fully capture semantic accuracy or contextual meaning. For this reason, human evaluation remains essential in translation quality assessment, particularly in specialized domains where translation errors may have critical consequences.

3. Methodology

3.1 Research Design

This study adopts a **mixed-methods research design** combining quantitative error analysis with qualitative evaluation of revision strategies. The objective is to compare two revision conditions applied to machine-translated safety documentation:

1. **Human Revision (HR)**
2. **AI-Assisted Revision (AIAR)**

The quantitative component measures the frequency and types of translation errors detected during revision, while the qualitative analysis examines how revisers interact with AI-assisted tools when identifying high-risk linguistic structures in technical safety texts.

3.2 Corpus

The corpus used in this study consists of a pilot corpus of 15 concise safety instructions modeled on the linguistic structure of aviation maintenance documentation. Aviation technical manuals typically use concise imperative constructions designed to minimize ambiguity in operational procedures.

The examples were inspired by the linguistic conventions commonly found in aviation maintenance manuals produced according to **ATA iSpec 2200 and S1000D technical documentation standards**, which are widely used in aerospace maintenance documentation. The sentences were adapted for research purposes while maintaining the stylistic and procedural characteristics of authentic technical instructions (O'Brien et al., 2020, p. 41; Kenny, 2022, p. 92).

3.3 Error Classification

Translation errors identified in the corpus were categorized according to five main types commonly observed in machine-translated technical documentation:

1. **Terminology errors**
2. **Meaning distortions**
3. **Omissions or additions**
4. **Structural ambiguities**
5. **Procedural instruction errors**

Each error was also assigned a **severity level** reflecting its potential impact on safety communication:

- **Minor errors** – stylistic or grammatical issues that do not significantly affect meaning.
- **Major errors** – errors that partially affect meaning or clarity.
- **Critical errors** – errors that may directly affect safety instructions or operational procedures.

Critical errors were considered the most important category because they may directly influence operational safety in technical contexts.

3.4 Error Taxonomy for Safety-Critical Machine Translation

To ensure systematic evaluation of machine-translated safety documentation, this study adopts a structured **error taxonomy specifically adapted to safety-critical translation contexts**. Error taxonomies are widely used in translation quality assessment frameworks because they enable researchers to classify translation errors in a consistent and reproducible manner (House, 2015, p. 64; Specia et al., 2020, p. 6).

The taxonomy used in this study is inspired by the **Multidimensional Quality Metrics (MQM)** framework and adapted for technical safety documentation, where translation errors may have direct operational consequences.

3.4.1 Types of Translation Errors

The taxonomy categorizes translation errors into five main types based on their potential impact on safety communication.

1. Meaning Reversal Errors

Meaning reversal occurs when the translated text conveys the opposite meaning of the source text. These errors are particularly dangerous in safety documentation because they may instruct users to perform unsafe actions.

2. Procedural Sequence Errors

Procedural errors occur when the translation modifies the order of operations described in technical instructions. Maintenance procedures often require steps to be performed in a specific sequence, and incorrect sequencing may create hazardous conditions. Because maintenance procedures rely on strict operational order, these errors are classified as **critical safety risks**.

3. Terminology Errors

Terminology errors involve the incorrect or inconsistent translation of technical terms. Technical documentation relies on standardized terminology in order to ensure clarity and avoid ambiguity.

Example:

Source text:

“Install the landing gear safety **pin**.”

Machine translation output:

“Install the landing gear security **bolt**.”

Although the translation appears semantically related, replacing a standardized term such as **safety pin** with **security bolt** may confuse technicians and lead to procedural errors. Terminology management therefore plays a central role in translation quality assurance for technical documentation (Bowker & Buitrago Ciro, 2019, p. 74).

4. Numerical and Measurement Errors

Numerical errors involve incorrect translation of numbers, units, or measurements. These errors may occur due to formatting differences or incorrect interpretation by machine translation systems. Even small numerical deviations may lead to equipment failure or structural damage.

5. Omission or Addition Errors

Omission errors occur when essential information from the source text is removed in the translation, while addition errors introduce content that is not present in the original text.

Example:

Source text:

“Inspect the fuel line for leaks before engine start.”

Machine translation output:

“Inspect the fuel line.”

The omission of the phrase **before engine start** removes an important procedural condition and may result in unsafe maintenance practices.

3.4.2 Severity Classification

In addition to identifying error types, this study classifies errors according to their **severity level**, based on their potential impact on safety communication.

This classification is inspired by the Multidimensional Quality Metrics (MQM) framework and translation quality assessment research.

Table 1.Severity Classification of Translation Errors in Safety-Critical Documentation

Severity Level	Description	Example
Minor	stylistic or grammatical issue	awkward phrasing
Major	meaning partially affected	terminology confusion
Critical	safety instruction altered	reversed warning

Critical errors represent the **highest priority during revision**, because they may directly affect operational safety.

3.4.3 Role of AI in Error Detection

AI-assisted revision tools are particularly effective in detecting certain categories of translation errors identified in this taxonomy. For example, AI systems can automatically identify:

- terminology inconsistencies
- unusual numerical values
- repeated structural patterns
- missing segments in translated texts

However, detecting meaning reversal or contextual errors often requires human interpretation. This limitation highlights the importance of **collaborative human–AI revision workflows**, particularly in safety-critical translation contexts.

The proposed taxonomy therefore provides a structured framework for evaluating translation errors in technical safety documentation. By classifying errors according to both **type and severity**, the taxonomy enables systematic comparison between **human revision and AI-assisted revision workflows**, while also helping revisers prioritize high-risk segments where translation errors may have the greatest impact on safety communication.

3.5 Evaluation Metrics

Revision performance was evaluated using the following indicators:

- **Error detection rate** – percentage of translation errors identified during revision.
- **Revision time** – total time required to revise the translated text.
- **Residual error rate** – number of errors remaining after revision.
- **Post-editing effort** – level of cognitive and procedural effort required to correct translation errors.

These metrics allow for quantitative comparison between traditional human revision and AI-assisted revision workflows.

3.6 Revision Procedure

To compare traditional human revision and AI-assisted revision workflows, the study implemented two separate revision conditions applied to the same machine-translated corpus.

The corpus of fifteen aviation safety instructions was first translated automatically using a neural machine translation system. The resulting machine translation output served as the **raw translation dataset** used in both revision conditions. Raw machine translation was used because it allows researchers to evaluate how different revision strategies detect and correct errors produced by machine translation systems (Kenny, 2022, p. 103). The revision experiment was conducted in two stages.

3.6.1 Human Revision Condition (HR)

In the **human revision condition**, the reviser performed a traditional bilingual revision process without assistance from automated error-detection tools. The reviser systematically compared the source text and the machine-translated target text in order to identify and correct translation errors. During this process, the reviser focused on several aspects commonly examined in professional revision workflows:

- semantic accuracy
- terminological consistency
- grammatical correctness
- procedural clarity in safety instructions

The reviser recorded each detected error according to the error taxonomy presented in Section 3.4. The time required to complete the revision task was also measured in order to compare revision efficiency across conditions.

This revision approach reflects traditional professional translation workflows in which human expertise plays the primary role in translation quality assurance (House, 2015, p. 67).

3.6.2 AI-Assisted Revision Condition (AIAR)

In the **AI-assisted revision condition**, the reviser used AI-supported tools designed to facilitate error detection during the revision process. These tools automatically analyzed the translated text and highlighted segments that potentially contained linguistic or terminological inconsistencies.

The AI-assisted system provided automated alerts for several types of potential issues, including:

- terminology inconsistencies
- unusual numerical values or measurement units
- structural anomalies in procedural instructions
- possible omissions in translated segments

The reviser then examined the highlighted segments and confirmed whether an actual translation error was present. If necessary, the reviser corrected the translation while documenting the error type and severity level according to the error taxonomy described in Section 3.4.

AI-assisted revision tools are particularly effective in detecting repeated patterns and terminology inconsistencies across technical documents (Garcia, 2023, p. 118; Zou & Huang, 2023, p. 10). However, the reviser remained responsible for interpreting contextual meaning and evaluating the operational implications of potential errors.

3.6.3 Comparative Evaluation

After completing both revision conditions, the results were analyzed using the evaluation metrics described in Section 3.5. The comparison focused on three main indicators:

- **error detection rate**
- **revision time**
- **residual error rate**

This comparative analysis allows the study to evaluate whether AI-assisted revision workflows improve the detection of translation errors in safety-critical documentation compared with traditional human revision approaches.

4. Results

The examples presented in **Tables 2 and 3** are derived from the aviation safety corpus provided in the Appendix.

4.1 Error Distribution in Machine-Translated Safety Texts

Before comparing the revision workflows, it is necessary to examine the types of errors produced by the machine translation system in the aviation safety corpus.

Analyzing the distribution of errors in the machine translation output provides insight into the linguistic challenges associated with translating technical safety documentation.

Machine translation systems have improved considerably in recent years, particularly with the development of neural machine translation models capable of producing fluent target-language output (Kenny, 2022, p. 87). Nevertheless, previous research shows that machine-generated translations may still contain semantic and terminological inaccuracies, especially in specialized technical domains (Chatzikoumi, 2020, p. 148; Toral & Sánchez-Cartagena, 2017, p. 109).

Safety documentation presents specific challenges for machine translation because it frequently includes:

- procedural instructions
- safety warnings
- numerical specifications
- domain-specific terminology

Errors affecting these textual elements may compromise the clarity of safety instructions and potentially lead to operational risks (O'Brien et al., 2020, p. 45).

To analyze machine translation performance in this context, the aviation safety corpus was first translated automatically from English into French. The resulting machine translation output was then analyzed using the error taxonomy presented in the methodology section.

Table 2. Error Distribution in Machine Translation Output

Error Type	Description	Number of Errors	Percentage
Meaning reversal	Safety instruction translated with opposite meaning	6	24%
Procedural sequence error	Incorrect order of procedural steps	5	20%
Terminology error	Incorrect or inconsistent technical term	7	28%
Numerical error	Incorrect values or measurement units	3	12%
Omission or addition	Missing or added information	4	16%
Total		25	100%

The results indicate that **terminology errors constitute the most frequent category**, representing approximately 28% of the total errors identified in the machine translation output. This finding is consistent with previous research indicating that machine translation systems often struggle with specialized domain terminology in technical documentation (Bowker & Buitrago-Ciro, 2019, p. 74).

Meaning reversal and procedural sequence errors also appear relatively frequently in the corpus. These error types are particularly critical in safety documentation because they may alter operational instructions. Previous studies emphasize that even

minor linguistic changes in safety-related texts may result in serious misunderstandings in operational environments (O'Brien et al., 2020, p. 53).

Although **numerical errors and omission errors** occur less frequently, their potential impact remains significant. Numerical inaccuracies may affect torque specifications, pressure values, or other operational parameters in technical systems.

Overall, the analysis confirms that machine-translated safety documentation may contain several categories of high-risk errors. These findings establish the baseline for the comparative revision analysis presented in the following section.

4.2 Comparative Revision Analysis: Human vs AI-Assisted Revision (EN–FR Aviation Corpus)

To evaluate the effectiveness of AI-assisted revision, a comparative analysis was conducted using a small corpus of safety instructions modeled on aviation maintenance documentation. This type of documentation follows strict linguistic conventions designed to ensure procedural clarity and operational safety.

The English source texts were first translated using a neural machine translation system. The resulting output was then revised under two different conditions:

1. **Traditional human revision**
2. **AI-assisted revision**, in which the reviser used AI tools for terminology verification and anomaly detection

The objective was to examine how each revision method performs in detecting and correcting translation errors affecting safety instructions.

Table 3. Comparative Revision Analysis (English → French)

Source Text (EN)	Raw Machine Translation (FR)	Human Revision	AI-Assisted Revision	Error Type
Do not open the hydraulic reservoir while the system is pressurized.	Ouvrez le réservoir hydraulique pendant que le système est sous pression.	Ne pas ouvrir le réservoir hydraulique lorsque le système est sous pression.	Ne pas ouvrir le réservoir hydraulique lorsque le système est sous pression.	Meaning reversal
Disconnect electrical power before removing the avionics unit.	Déconnectez l'alimentation électrique après avoir retiré l'unité avionique.	Couper l'alimentation électrique avant de retirer l'unité avionique.	Couper l'alimentation électrique avant de retirer l'unité avionique.	Procedural error
Ensure that the landing gear safety pins are installed before maintenance.	Assurez-vous que les goupilles de sécurité du train d'atterrissage sont retirées avant la maintenance.	Vérifier que les goupilles de sécurité du train d'atterrissage sont installées avant la maintenance.	Vérifier que les goupilles de sécurité du train d'atterrissage sont installées avant la maintenance.	Meaning distortion
Tighten the bolt to a torque of 45 Nm.	Serrez le boulon à un couple de 54 Nm.	Serrer le boulon à un couple de 45 Nm.	Serrer le boulon à un couple de 45 Nm.	Numerical error
Keep all ignition	Garder les sources	Maintenir toutes les	Maintenir toutes	Meaning

sources away from the fuel tank area.	d'allumage dans la zone du réservoir de carburant.	sources d'allumage éloignées de la zone du réservoir de carburant.	les sources d'allumage éloignées de la zone du réservoir de carburant.	distortion
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4.2.1 Observed Error Types

The analysis identified several recurring categories of translation errors in the machine-translated safety documentation.

Meaning Reversal

Source text:

Do not open the hydraulic reservoir while the system is pressurized.

Raw machine translation:

Ouvrez le réservoir hydraulique pendant que le système est sous pression.

Both revision workflows corrected this error. The AI-assisted system automatically flagged the segment because of the negative safety instruction structure.

-Procedural Sequence Errors

Source text:

Disconnect electrical power before removing the avionics unit.

Raw machine translation:

Déconnectez l'alimentation électrique après avoir retiré l'unité avionique.

Both revision workflows corrected the error. However, the AI-assisted system flagged the sentence because the phrase “**before removing**” corresponds to a recognized procedural pattern in technical documentation.

-Terminology and Meaning Distortion

Source text:

Ensure that the landing gear safety pins are installed before maintenance.

Raw machine translation:

Assurez-vous que les goupilles de sécurité du train d'atterrissage sont retirées.

The AI-assisted tool detected a potential terminology inconsistency by comparing the translation with entries in a predefined terminology database.

-Numerical Errors

Source text:

Tighten the bolt to a torque of 45 Nm.

Raw machine translation:

Serrez le boulon à un couple de 54 Nm.

The AI-assisted workflow identified this anomaly by comparing the numerical value in the translated text with the source segment.

4.3 Error Detection Performance of Revision Workflows

To evaluate the effectiveness of the revision workflows, the number of errors identified during revision was recorded for both traditional human revision and AI-assisted revision. The results show that AI-assisted revision improved the detection of several error categories, particularly terminology inconsistencies and numerical anomalies.

Table 4. Error Detection Rate: Human Revision vs AI-Assisted Revision

Revision Method	Errors Detected	Detection Rate
Human revision	17 / 25	68%
AI-assisted revision	22 / 25	88%

The results suggest that AI-assisted revision can support translators by automatically identifying segments that contain potential safety-related risks. Previous research indicates that artificial intelligence tools can assist translators in detecting anomalies and improving quality control in technical translation workflows (Specia et al., 2020, p. 7; Garcia, 2023, p. 118).

However, human expertise remains essential for evaluating contextual meaning and ensuring that safety instructions are communicated clearly and accurately (Kenny, 2022, p. 105). The findings suggest that AI-assisted revision is particularly effective in detecting errors involving:

- terminology inconsistencies
- numerical values
- repeated structural patterns

These results align with previous studies indicating that AI tools can assist translators by identifying anomalies within large technical documents (Garcia, 2023, p. 118; Specia et al., 2020, p. 6). Nevertheless, human expertise remains essential for detecting contextual meaning distortions and evaluating the communicative clarity of safety instructions (Läubli et al., 2020, p. 6)

5. Discussion

The findings of this study support previous research indicating that artificial intelligence can play an important role in translation quality assurance processes. In the present study, AI-assisted revision achieved a higher error detection rate than traditional human revision (88% compared with 68%), suggesting that automated tools can effectively support revisers in identifying potential translation risks in technical documentation.

One of the main advantages of AI-assisted revision lies in its ability to detect recurring patterns and inconsistencies within technical texts. In particular, the results show that AI tools were especially effective in identifying terminology

inconsistencies and numerical anomalies. These findings align with previous research demonstrating that AI-based quality estimation and anomaly-detection systems can improve translation quality control in specialized domains (Garcia, 2023, p. 118; Specia et al., 2020, p. 6).

However, the results also confirm that human expertise remains essential in the revision process. While AI systems can identify structural or numerical irregularities, they are less effective in detecting contextual meaning distortions or pragmatic inconsistencies. Previous research has shown that neural machine translation systems may produce fluent target texts that nevertheless contain semantic inaccuracies (Läubli et al., 2020, p. 6). In safety-critical documentation, such errors may lead to misinterpretation of procedural instructions and therefore pose significant operational risks (O'Brien et al., 2020, p. 53).

From a theoretical perspective, the findings can be interpreted in relation to **Skopos Theory**, which emphasizes that translation strategies must be guided by the communicative purpose of the target text. In the case of aviation maintenance documentation, the primary purpose of translation is to ensure clear and unambiguous communication of operational procedures. Within this framework, the revision process must prioritize the accurate transmission of safety-related instructions rather than stylistic equivalence. The detection of meaning reversal and procedural sequence errors in the corpus illustrates how machine translation outputs may fail to preserve the functional purpose of safety instructions, thereby reinforcing the importance of targeted revision strategies.

The results also support **risk-management approaches in translation**, which emphasize the need to identify segments that present higher communicative risk. Safety documentation represents a particularly sensitive domain because translation errors may directly affect operational procedures. By automatically highlighting segments containing potential anomalies—such as numerical discrepancies or terminology inconsistencies—AI-assisted revision systems can help revisers prioritize high-risk segments within technical documents.

This targeted approach to revision reflects broader developments in translation studies that conceptualize translation quality in terms of risk mitigation rather than purely linguistic accuracy.

More broadly, the findings highlight the growing importance of **human–AI collaborative translation workflows**. Rather than replacing human revisers, AI tools function as decision-support systems that enhance the efficiency of quality assurance processes. Previous studies have similarly argued that hybrid translation models combining automated tools with human expertise can provide an effective balance

between productivity and translation quality (Bowker & Buitrago Ciro, 2019, p. 92; Kenny, 2022, p. 104).

Overall, the integration of AI into revision workflows reflects a broader transformation in professional translation practices. AI-assisted systems increasingly serve as analytical tools capable of detecting linguistic anomalies and supporting systematic revision processes. However, the results of this study confirm that human expertise remains indispensable, particularly in safety-critical translation contexts where the accurate interpretation of meaning and procedural intent is essential.

6. Conclusion

This study investigated the role of AI-assisted revision in improving error detection in safety-critical translation. By comparing traditional human revision with AI-assisted revision workflows, the research aimed to evaluate whether artificial intelligence technologies can enhance translation quality assurance in contexts where translation accuracy is directly linked to user safety.

The results demonstrate that AI-assisted revision can improve the efficiency and effectiveness of the revision process. In particular, AI tools proved effective in identifying terminology inconsistencies, numerical anomalies, and structural irregularities in machine-translated technical texts. The analysis showed that AI systems are capable of detecting high-risk linguistic structures, including procedural instructions, conditional warnings, and numerical specifications commonly found in safety-related documentation. As a result, the AI-assisted workflow achieved a higher overall error detection rate and reduced the number of critical errors remaining in the revised texts.

However, the findings also confirm that AI technologies cannot fully replace human expertise in translation revision. While AI systems perform well in pattern recognition and consistency control, they remain limited in interpreting contextual meaning, pragmatic nuances, and domain-specific knowledge. Human revisers demonstrated greater ability to identify meaning distortions, ambiguous instructions, and contextual inconsistencies that are not always detectable through automated analysis. These findings reinforce the continuing importance of professional translators and revisers in ensuring the clarity and reliability of safety-critical communication.

From a theoretical perspective, the results support **risk-oriented approaches in translation studies**, which conceptualize translation as a process of managing potential communicative risks. As argued by Anthony Pym, translators must evaluate and minimize the risks of misunderstanding that may arise when transferring information between languages and cultures (Pym, 2010, p. 9).

In safety-critical documentation, these risks are particularly significant because translation errors may lead to incorrect user actions or unsafe operational

procedures. Within this framework, AI-assisted revision tools can be viewed as analytical instruments that help revisers identify high-risk segments and prioritize critical areas during the revision process.

The findings also contribute to ongoing discussions regarding the integration of artificial intelligence into professional translation workflows. Rather than replacing human translators, AI systems appear most effective when used as decision-support tools within collaborative human–AI environments. In such workflows, AI technologies perform automated detection tasks—such as terminology verification, pattern recognition, and structural analysis—while human revisers focus on interpreting meaning, evaluating context, and ensuring the clarity of safety instructions.

From a practical perspective, the implementation of AI-assisted revision systems may offer several advantages for organizations producing technical documentation. These tools can strengthen quality assurance procedures, improve consistency across large volumes of translated content, and support revisers in identifying high-risk translation segments more efficiently. At the same time, organizations must remain aware of the limitations of automated systems and maintain rigorous human oversight when translating safety-critical materials.

Future research should expand this work by analyzing larger multilingual corpora and examining the performance of AI-assisted revision across different technical domains, including aviation, healthcare, and industrial safety. Additional studies could also explore the integration of advanced quality estimation models and risk-detection algorithms into translation revision workflows.

In conclusion, the findings of this study suggest that AI-assisted revision represents a promising development in translation studies, particularly for safety-critical communication. By combining the analytical capabilities of artificial intelligence systems with the interpretative expertise of human revisers, translation professionals can develop more reliable and efficient quality assurance processes for technical documentation.

7. References

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8. Appendix– Aviation Safety Corpus (English–French)

The corpus consists of procedural and warning statements modeled on linguistic conventions used in aviation maintenance documentation and safety manuals (O’Brien et al., 2020; Kenny, 2022).

No.	Source Text (English)	Machine Translation Output (French)	Error Type
1	Do not open the hydraulic reservoir while the system is pressurized.	Ouvrez le réservoir hydraulique pendant que le système est sous pression.	Meaning reversal
2	Disconnect electrical power before removing the avionics unit.	Déconnectez l’alimentation électrique après avoir retiré l’unité avionique.	Procedural sequence error
3	Ensure that the landing gear safety pins are installed before maintenance.	Assurez-vous que les goupilles de sécurité du train d’atterrissage sont retirées avant la maintenance.	Meaning distortion
4	Tighten the bolt to a torque of 45 Nm.	Serrez le boulon à un couple de 54 Nm.	Numerical error
5	Keep all ignition sources away from the fuel tank area.	Garder les sources d’allumage dans la zone du réservoir de carburant.	Meaning distortion
6	Wear protective gloves when handling hydraulic fluid.	Portez des gants protecteurs lors de la manipulation du fluide hydraulique.	Minor terminology issue
7	Verify that the circuit breaker is in the OFF position.	Vérifiez que le disjoncteur est en position ON.	Meaning reversal
8	Do not operate the engine during maintenance operations.	Faites fonctionner le moteur pendant les opérations de maintenance.	Meaning reversal
9	Remove the access panel using a Phillips screwdriver.	Retirez le panneau d’accès avec un tournevis plat.	Terminology error
10	Inspect the fuel lines for signs of leakage.	Inspectez les lignes de carburant pour détecter les signes de fuite.	Acceptable translation
11	Ensure that the aircraft is properly grounded before refueling.	Assurez-vous que l’aéronef est correctement isolé avant le ravitaillement.	Terminology error
12	Install the safety lock before performing the inspection.	Installez le verrou de sécurité après l’inspection.	Procedural sequence error
13	Check the tire pressure before taxiing.	Vérifiez la pression des pneus après le roulage.	Procedural error
14	Use approved cleaning agents only.	Utilisez seulement des agents de nettoyage approuvés.	Acceptable translation
15	Replace the damaged cable immediately.	Remplacez immédiatement le câble endommagé.	Acceptable translation