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| RESEARCH ARTICLE

Certainty and Uncertainty in the Abstract Section of Mechanical Engineering Research Articles

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| ABSTRACT
The study of epistemic modality in research articles (RAs) has been found in many papers. However, the investigation of epistemic modality in the abstract section of RAs viewed from Systemic Functional Linguistics is rarely conducted, especially in mechanical engineering RAs. Therefore, the purpose of this study was to investigate the roles of epistemic modality in the abstract section of mechanical engineering RAs. A number of 50 abstracts were collected from Scopus Q-1 journal of mechanical engineering entitled "International Journal of Machine Tools and Manufacture" in the period of 2016-2020. The data were analyzed using the Systemic Functional Linguistics framework focusing on epistemic modality markers in terms of orientation and values. The results reveal that the writers of mechanical engineering RAs tend to use epistemic modality markers as objective implicit and explicit orientation only since there is no subjective implicit or explicit orientation found in the data. Furthermore, the findings also show that the writers apply epistemic modality markers mostly with low values instead of median or high values. These results may be used to improve the academic writing ability of mechanical engineering writers, especially in writing abstract sections.

| KEYWORDS

Epistemic modality, Abstract section, Mechanical engineering, Systemic Functional Linguistics, Orientation, Values

| ARTICLE INFORMATION

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1. Introduction

English is well known as a working language in business, communication, and education, especially in South East Asian. The use of English has increased significantly in academic society as a tool of advanced education communication, either written or spoken. Among all academic writing genres, abstracts are one of the crucial means of communication among scholars across academic disciplines (Kanoksilapatham, 2013). Abstracts, whether treated as a sub-genre of the RA genre (Swales & Feak, 2009 p. 9) or a genre integrated into the larger genre of RAs (Biber & Conrad, 2019), play a critical role. They have four distinguished functions listed by Huckin (2001) in (Swales & Feak, 2009). First, they serve as stand-alone mini-texts, giving readers a short summary of a study's topic, methodology, and findings. Second, they function as screening devices, helping readers decide whether they wish to read the whole article or not. Third, they function as previews for readers intending to read the whole article, giving them the road map for their reading. Fourth, they provide indexing for professional abstract writers and editors. In the words of Salager-meyer (1990), attention should be paid to abstracts because they are the readers' first encounter with the text and because they assume a vital role in scientific development. Accordingly, researchers should pay much closer attention to the structure of the abstracts.

The studies of the abstract section of research articles (RA) have been viewed from various lenses. Most studies tend to be conducted using the genre analysis of Swales (Al-Khasawneh, 2017; Alhuqbani, 2013; Alyousef, 2021; Bhatti et al., 2019; Duan & Wei, 2021; Farzannia, 2017; Gries et al., 2016; Kanoksilapatham, 2013; Salager-Meyer, 1990; Zhao & Wu, 2013; Kurniawan et al., 2019) to mention a few. Other focus on Martin & White's (2005) appraisal system (Ili, 2022), mood choices (Olaniyan, 2020),

transitivity (Vathanalaoha & Tangkiengsirisin, 2018), and unmarked theme (Heng & Ebrahimi, 2012). Although (Taşpınar (2017) investigated epistemic modality in the abstract section of RAs, the study did not view epistemic modality from Systemic Functional Linguistics; instead, it focused on the investigation of epistemic modality used as hedges and boosters in two different journals: International Journal of Educational Research (IJER) and International Journal of Engineering Science (IJES). It means that the study of epistemic modality in the abstract section, especially in mechanical engineering RAs, using the Systemic Functional Linguistics approach is still widely open.

Epistemic modality has been defined in various ways. According to (Lyons, 1977), epistemic modality refers to the logical structure of statements that assert or imply that a particular proposition, or set of propositions, is known or believed. It serves as the expression of the speaker's assumptions or assessment of possibilities and, in most cases, the speaker's confidence (or lack of confidence) in the truth of the proposition expressed (Coates, 1983). In the words of (Palmer, 2014), it is to make judgments about the possibility. Whereas Halliday (2004) stated that epistemic modality refers to the degree of probability, which is a type of modalization. Whatever definition it is, epistemic modality is concerned with the expression of certainty and uncertainty.

The expression of certainty or confidence and uncertainty are the rhetorical and interactive nature of academic writing. Its significance stems from the fact that academics achieve acceptance for their study findings by striking a balance between conviction and caution, investing statements with the confidence of trustworthy information, or with tentativeness to indicate doubt or acceptable social relations (Hyland, 1998). This can be achieved by employing epistemic modality as a type of rhetorical device. Based on Systemic Functional Linguistics (SFL), epistemic modality works on orientation and value. The orientation will express judgments either explicitly or implicitly subjective, while values will determine certainty or uncertainty under three categories: low, median, and high (Halliday & Matthiessen, 2013). Hence, this study raised two issues here.

- What are the frequency and distribution of various values and orientations of epistemic modality used in the abstract section of high impact factor engineering RAs?
- What are the possible functions of the values and the orientations used in the abstract section of high impact factor engineering RAs?

The findings of this study will have a significant impact, especially on those who are involved in English for Specific Purposes or Academic Purposes. The findings may become a valuable resource on how to use epistemic modality appropriately in writing an abstract, especially mechanical engineering RAs. One function of epistemic modality is to, either theoretically or practically. Regarding a disciplinary will strongly influence the language used.

2. Literature Review

According to Halliday & Matthiessen (2013, 691), modality is described as the area of meaning that lies between yes and no – the intermediate ground between positive and negative polarity. Depending specifically on the underlying speech function of the clause, modality can be categorized into modalization and modulation. Modalization refers to either probability or usuality, while modulation can be obligation or inclination. Thus, there are four types of modality systems, as illustrated in the figure below.

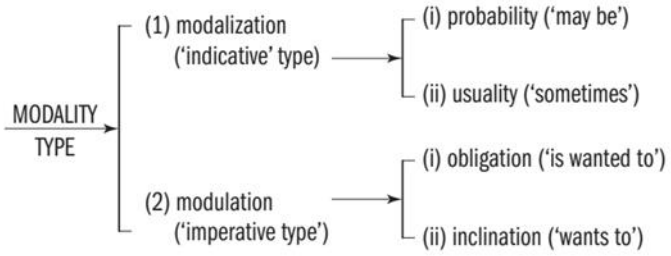

Figure 1. System of types of modality (Halliday & Matthiessen, 2013, 691)

In philosophy, probability is known as an epistemic modality in which the word 'epistemic' is derived from the Greek word episteme, meaning 'knowledge'. That is why the meaning of the clause containing epistemic modality has the speech function as a proposition, a statement or assertion that expresses a judgement or opinion. In expressing an opinion, there are several ways available that can be chosen by the speaker or writer. Based on orientation, epistemic modality can be viewed from the subjectivity or objectivity of the speaker or writer (Halliday & Matthiessen, 2013), as exemplified below.

1. *I guess we were a pretty pragmatic lot – including me*. (subjective explicit)
2. *Family background, fellow artists and friends may be glimpsed in amiable disguise*. (subjective implicit)
3. *It is certain that he would never yield to the blackmail of the insubordinate generals*. (objective explicit)
4. *Under the Montreal Protocol, the concentration of chlorine will certainly rise to at least 5 ppbv and possibly to as high as 8 or 9 ppbv.* (objective implicit)

Subjective explicit is realized by projecting mental clause and idea clause as in 1), while subjective implicit is realized by a clause containing Mood as Finite as in 2). On the other hand, objective explicit is realized by relational clause with factual Carrier: clause and modal Attribute: nominal group as in 3), and objective implicit is realized by Mood – as mood Adjunct: modal adverb as in 4) (Halliday & Matthiessen, 2013). In brief, orientation consists of two types: subjective and objective orientation, each of which has explicit or implicit orientation, as shown in Figure 2.

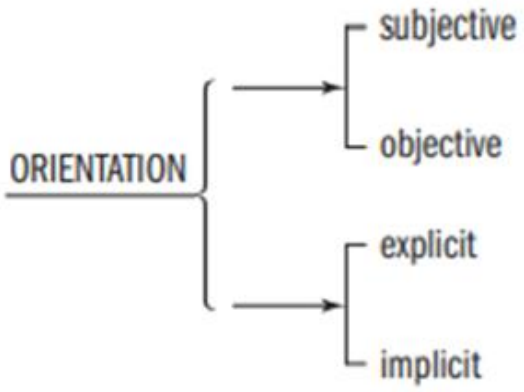

Figure 2. System of types of orientation in epistemic modality

3. Methodology

As a part of the data gathering process, all data were searched and extracted from the abstract of 50 RAs chosen from a mechanical engineering journal entitled "International Journal of Machine Tools and Manufactures". This journal has Scopus indexed of Q-1 with SJR 3.403. The corpus was only taken from the abstract section of the articles consisting of a single paragraph published between 2016–2020. Ten RAs were randomly chosen from each year. There is no discrimination concerning the authors since the journal is Q-1 Scopus indexed and published by Elsevier, assuming that all the articles published have gone through a tight screening both in content and language. The total word numbers of the RAs are 11901.

In processing the corpus, Antconc was used. First, the corpus was sorted based on epistemic modals. Next, they were classified in terms of value categories: high, median, and low, as illustrated in Table 1.

Table 1. Examples of Value categories from the corpus

Value categories	**Examples from corpus**
High	The simulation **demonstrated** that the resultant profile was found to
Median	these assumptions **will** weaken the mathematical relationship ….
Low	But this chatter suppression mechanism **may** considerably be disturbed by the inevitable tool….

In the examples, high value epistemic modality is indicated by the lexical epistemic modal verb demonstrated, the median value category is realized by epistemic modal auziliary will, and the low value category is expressed by epistemic modal auxiliary may. Then, the corpus was classified based on orientation. In the corpus, only objective orientations were found, both explicit and implicit. Some instances from the corpus are in Table 2. Finally, based on the value and orientation parameters, they were analyzed before the conclusion was drawn.

Table 2. Example of Orientation types from corpus

Orientation type	Examples
Objective Explixit	The experiment results show that chatter is effectively controlled by …. The experimental results indicate that the maximum duration of the time ….
Objective Implicit	This study demonstrated a facile technique for fine control of…. cost/time efficiency of this new approach will be a significant benefit to fundamental research …

4. Results and Discussion

4.1 Results

Figure 3. shows that there are 11 epistemic modals found in 1563 data. They are can, could, may, suggest, propose, will, indicate, conclude, demonstrate, and require. The epistemic modals are realized only by modals and verbs, and no adverbs are found. Epistemic modal can appear to have the highest frequency, followed by propose, will, show, could, demonstrate, suggest, indicate, may, require and conclude. Whereas (Bo & Ma, 2022), who investigated English-medium RAs of Artificial Intelligent journals excluding abstract sections, found three types of epistemic modals. This difference may be the result of the different kinds of disciplinary and sub-genre studied.

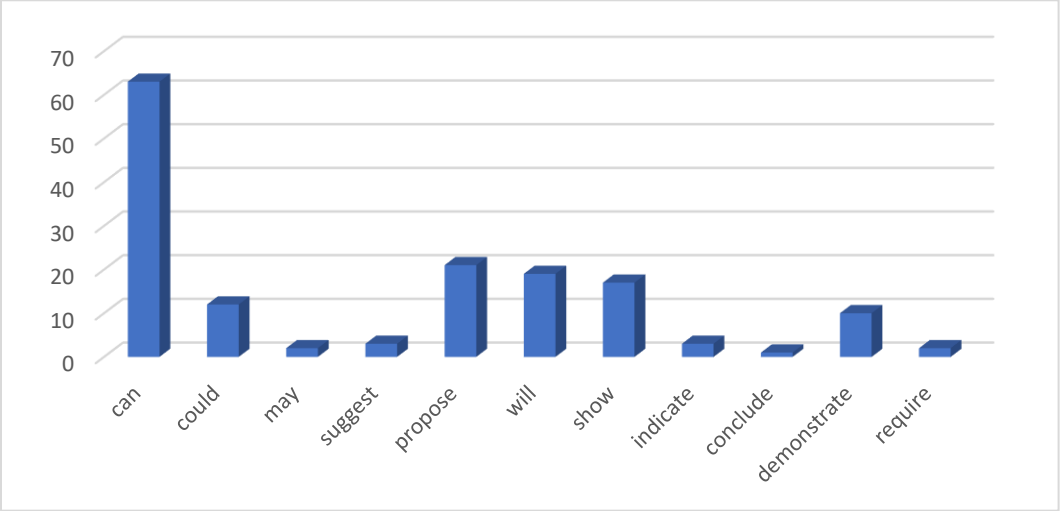

Figure 3. Distribution of epistemic modals

Figure 4. reveals that only Objective Explicit and Objective Implicit are found, while Subjective Explicit and Implicit orientations do not appear in the data. Objective Implicit is used almost five times as much as Objective Explicit. Whereas in Artificial Intelligence RAs, Bo & Ma (2022) listed all types of orientation. Furthermore, Yang et al. (2015) did not find Subjective Explicit orientation in English-medium medical RAs, in which the abstract section was excluded from the data. The difference in the findings seems influenced by the disciplinary of the RAs.

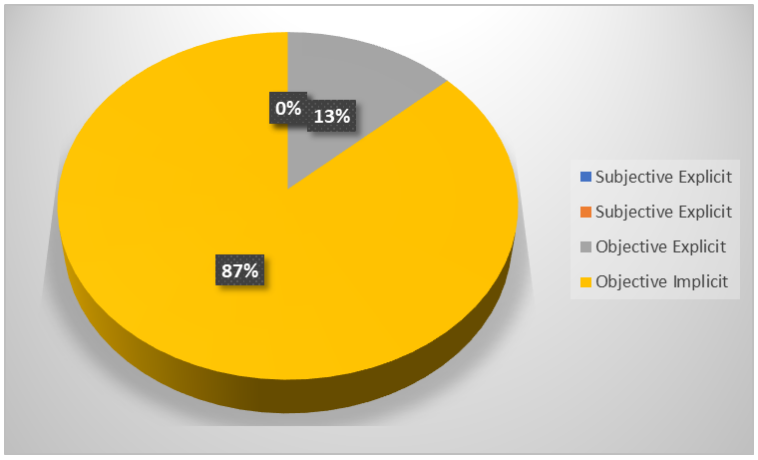

Figure 4. Distribution of orientation types

Meanwhile, all categories of values: high, median, and low, are found in the data. As shown in Figure 5., a low value is dominantly used compared with the two other categories: median and high. Although this result is in line with what was found by Yang et al. (2015) in English-medium medical RAs, the medium value was not used in English-medium medical RAs. Conversely, in English-medium Artificial Intelligence RAs, the highest frequent use of value was high one, although all categories are also found. It seems there is always a tendency that the disciplinary of the RAs will strongly influence the choices of orientation types or value categories.

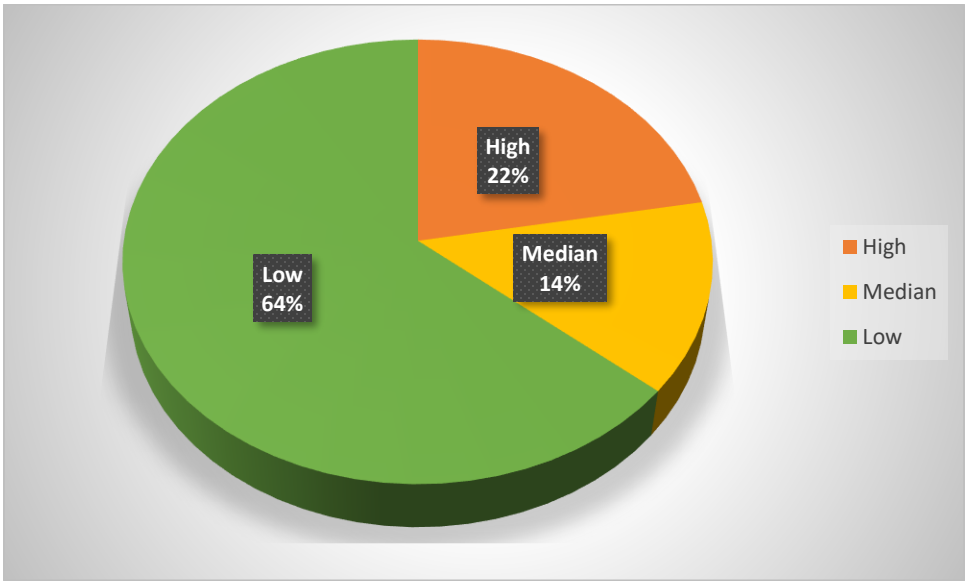

Figure 5. Distribution of Value categories

4.2 Discussion

Epistemic modality is a crucial yet complicated linguistic device in RA writing that is challenging to understand and implement (Yang et al., 2015). To obtain an understanding of epistemic modality in mechanical engineering writing, 50 abstracts of English-medium mechanical engineering RAs were investigated from the lens of Systemic Functional Linguistics. In spite of the relatively small sample as well as a single focus on the abstract section only, the results reveal that the writers of mechanical engineering RAs tend to make claims that are cautious, reserved and objective, as will be discussed here.

4.3 Subjectivity and Objectivity

Among the four orientations, the findings reveal that only objective orientations, both implicit and explicit types mark the prominence of objective statements by implicitly stating the objective source of conviction. This implies that the writers convey the objectivity of the statement and blur the relationship between the writer and the statement by concealing the role of the writer in the assessment of the proposition, as argued by Yang et al. (2015).

In this corpus, objective implicit orientation occupies the data predominantly with approximately five times objective explicit one (Figure 4.). The samples below illustrate such a kind of orientation.

(1) The scratch at 170 \xB0C **can** achieve more ductile-regime surfaces with a ….
(2) The size of the nanopores **can** be accurately tuned by adjusting the electron …
(3) A deep ductile-cut region of silicon **can** be achieved by UPFC with a large ….
(4) The micro roof array **could** be fabricated on the top of the ….
(5) This study **proposed** a numerical model to investigate the flowing
(6) A novel intermittent-sawtooth drill structure is **proposed** on the one-shot drill.
(7) Cost/time efficiency of this new approach **will** be a significant benefit to fundamental research …
(8) The procedure presented herein **will** facilitate the design and optimization of the ….
(9) The results **demonstrate** the effectiveness of the presented controller ….
(10) Vibration response test and a modal test **demonstrate** the feasibility of the fractal contact….
(11) This study **demonstrated** a facile technique for fine control of….
(12) Geometric error identification is **required** for volumetric error compensation.

As these examples illustrate, the source of modality is present only in modality with objective implicit orientation. They are indicated by factual subjects instead of animate ones. The objective implicit orientation is realized by epistemic modal can, could, will,

proposed, demonstrate, and required. By using these epistemic modals, the writers show politeness and try to transmit an implicit recognition of alternative voices in their approach, as stated by Bo & Ma (2022).

Another type of orientation found in the corpus is objective explicit orientation. The samples (13)-(18) below illustrate it. Unlike objective implicit orientation, which tends to be realized by clause simple of relational process clauses, objective explicit orientation is realized by clause complexes. The subject of the main clause is also realized by the inanimate subject referring mostly to data results, as also confirmed by other researchers (Bo & Ma, 2022; Yang et al., 2015). And modal expressions are frequently realized by modal lexical verbs suggest, show, and indicate.

(13) The results **suggest** that the actual drill/CRFP interactions ….
(14) The estimated shape changes **show** quantitatively good agreement with the experiment ….
(15) The results **show** that chatter can be well predicted ….
(16) The experiment results **show** that chatter is effectively controlled by ….
(17) The experimental results **indicate** that the maximum duration of the time ….
(18) These results **indicate** that the rounding phenomenon at the tips ….

4.4 Certainty and Uncertainty

As illustrated in figure 5., the findings show that low value dominated the abstract of mechanical engineering RAs (64%). This indicates that mechanical engineering writers prefer to express uncertainty rather than certainty about their stated propositions. These findings confirm those of Yang et al. (2015) study of epistemic modality in English-medium medical RAs,, but they seem to be the opposite of Bo & Ma's (2022) investigation of epistemic modality in English-medium Artificial Intelligence RAs. Some instances of the low value of epistemic modals found in the corpus of abstract sections of mechanical engineering RAs are presented below.

4.5 Statement with low value

(19) The size of the nanopores **can** be accurately tuned by adjusting the electron….
(20) The use of bipolar pulses **could** effectively inhibit passive film growth on the….
(21) But this chatter suppression mechanism **may** considerably be disturbed by the inevitable tool….
(22) ISF based hole-flanging processing method is **proposed** by developing a new ISF flanging tool….

Low value epistemic modality appears to be the highest frequency in the corpus. It is expressed by modalities can, could, may, and lexical modal verbs proposed and suggest. Mechanical engineering writers' preference for using uncertainty expressions seems to be bound up with their attempts to gain readers' acceptance of their claims. Thus, their claims in the RAs can be transformed into established knowledge (Yang et al., 2015). Low value and median value used in the claims can diminish the possibility of disagreement from the readers (Martín-Martín, 2008). And the application of these value categories appropriately can provide a space for the readers to accept the claims of mechanical engineering RA writers.

4.6 Statement with median value

As illustrated in Figure 5., the median value of epistemic modality has the lowest frequency of 14%. This category uses will and indicates frequently. The samples (23)-(25) show the use of the models in epistemic modality. The use of epistemic modal will and lexical modal verb indicate serve to bring a certain degree of politeness to the discourse. Accordingly, the writers give space for the readers to agree and accept their claims.

(23) The resultant angular motion **will** violate the angular constraints
(24) these assumptions **will** weaken the mathematical relationship
(25) These results **indicate** that the rounding phenomenon at the tips

4.7 Statement with High Value

High value epistemic modality is used more frequently (22%) than the median one. It tends to be realized by lexical modal verbs demonstrated, show and required. The function of high value epistemic modality is to express a strong commitment to the truth of the utterance.

(26) The simulation **demonstrated** that the resultant profile was found to
(27) The models **show** that the surface roughness decreased with
(28) CWR tests and different die geometries are **required** in the identification of the potential

5. Conclusion

The investigation of epistemic modality in abstract sections of mechanical engineering RAs concerning values and orientations indicates two essential findings. First, mechanical engineering writers tend to apply low values mostly instead of high and median ones. It serves to make their claims accepted by the readers through decreasing certainty. Second, they present their claims objectively, either explicitly or implicitly. This indicates that they prefer to blur the relationship between the writer and their claims to show objective orientation. These findings can help novice writers of mechanical engineering use epistemic modality appropriately in RAs, especially in the abstract section. It is essential that abstracts tend to be part of RAs which may invite readers to read the RAs, which in turn they may be cited.

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