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THE ROLE OF MODAL VERBS IN RESEARCH PAPERS IN THE FIELD OF LOGISTICS

Abstract

Research papers, an essential vehicle for disseminating new knowledge and findings, have long been valued for their linguistic objectivity and impersonality. However, more recent approaches to research paper writing suggest that authors should also take an "argumentative position" (White, 2003) by projecting their stance and encouraging the readers to actively engage in the process of reading and evaluating the text (Hyland, 2005; Scollon, 1994). An important linguistic feature, frequently employed for both objective and subjective presentation of claims, is modality and within it modal verbs, which through their modal meanings express different communicative functions. In recognition of genre- and discipline-specific norms, the present paper will focus on quantitative and qualitative analysis of modal verbs and their meanings and functions in logistics research papers, whereby the ultimate goal is to show what practical implications the study's results may have for the teaching of English to students of logistics.

Keywords: logistics, research papers, modal verbs, objectivity, subjectivity, discipline-specific language use

1. Introduction

Research papers are a key vehicle for disseminating new knowledge and findings. Despite the long-accepted view that academic writing should preferably maintain a neutral tone and remain "objective, faceless and impersonal" (Hyland, 2005: 173), it is now advocated that the authors of research papers should also aim to present their topics in a way that projects their stance on the findings and views presented in the text and encourages the readership to actively engage in the process of reading and evaluating the text (Hyland, 2005; Scollon, 1994). The author's stance and the reader's engagement can be expressed and encouraged with various linguistic resources, including wordings commonly grouped under the headings attribution, concession, consequentiality, evidentiality, hedging, modality and polarity (White, 2003). Such wordings include modal verbs, which are used to express modality and which through their modal meanings – dynamic, epistemic and deontic – can express the author's qualification of commitment to or detachment from the claims they make (ibid.). A related and frequently addressed function of modal verbs in research papers is hedging or "mitigation of claims" (Vold, 2006: 62), which, as a rule, is expressed through epistemic modality.

Since research papers predominantly aim at an international audience, most of them are written in English, which, as pointed out by Hyland (2007), has gradually but steadily become the lingua franca in academia. Accordingly, academic writing in English has gradually established itself as one of the researcher's key skill sets, requiring both a thorough understanding of and expertise in a discipline as well as in genre- and discipline-specific discourse conventions. Given that research papers in English are also an academic genre that is frequently used to familiarise students of various disciplines with new knowledge claims in their respective field of study (Hewings, 2006), academic writing and especially reading skills have also been recognised as crucial to tertiary level students. In recognition of the importance of well-informed academic reading and writing, especially for researchers and students, many linguistic scholars have dedicated their efforts to studying the lexical, grammatical and rhetorical characteristics (Hyland, 2006) of research papers, which commonly include modality. Studies of modality in research papers take different approaches and vary in their focus. Taking a cross-disciplinary or a cross-linguistic approach, or a combination of both, some previous studies thus focus on modalities of obligation (e.g. Giltrow, 2005), the use of epistemic modality markers for hedging (e.g. Vold, 2006), and the dichotomy between epistemic and deontic modality (e.g. Piqué-Angordans, Posteguillo, & Andreu-Besó, 2002). However, to date, studies of modality in research papers have focused on traditional disciplines, such as medicine, biology, marketing and literary criticism, which leaves logistics an area that still needs to be investigated from this perspective. As a contribution to filling this gap, the present study aims to shed light on the use of modal verbs in logistics research papers, the results of which may have practical implications for the teaching of English to students of logistics as well as for researchers publishing papers in this field. In the light of these goals, the study first seeks to determine whether polysemous modal verbs in logistics research papers show a preference for any of the three modal meanings and related communicative function(s). Secondly, it tries to show how the use of modal verbs may reflect the dichotomy between subjective and objective presentation of claims. Finally, the study also aims to draw parallels between the evidenced use of modal verbs and the markedly interdisciplinary nature of logistics, as well as to provide

practical examples of ESP teaching material that could help raise students' awareness of genre- and discipline-specific use of modal verbs in logistics research papers.

The paper sets out with a brief overview of the role of modal verbs in research papers, which relates Palmer's categorisation of modal meanings (1990 and 2003) to recent studies on modality in research papers. This is followed by an outline of the corpus and methodology used in the research and presentation of the results of a quantitative and qualitative analysis of modal verbs. The paper concludes with an insight into the potential practical implications of the results, the presentation of the limitations of the study and suggestions for further research.

2. Modal verbs and their modal meanings in research papers

In English, modal verbs are the principal and best-known among the methods for expressing modality (Depraetere & Reed, 2006; de Haan, 2006). Since modality is a grammatical category typically employed by writers to express their "judgment that a proposition is possibly or necessarily true or that the actualization of a situation is necessary or possible" (Depraetere & Reed, 2006: 269), modal verbs thus represent one of the major linguistic features that define research papers as a distinct genre, which has been recognised by various authors, including Giltrow (2005), Piqué-Angordans et al. (2002) and Vihla (1999). From this perspective, the majority of studies on modality and modal verbs in research papers aim to provide insight into the use of different communicative functions of modal verbs in shaping the textual voice and the ways in which their genre- and discipline-specific use reflects "the conventions of disciplinary genres" (Vihla, 1999: 1). Nowadays, a commonly accepted approach to studying any linguistic feature, including modality, takes a genre- and discipline-specific perspective; nevertheless, the role of specific norms has been questioned by a number of studies on academic discourse. The historical overview of such studies shows that over time focus shifted from disciplinary to genre variation, and back to disciplinary variation, while today the commonly accepted approach to the analysis of disciplinary genres, as explained by Bhatia (2002: 29), takes "into account disciplinary variations in ways that complement the genre-based view of discourse". Following Bhatia's and other related views on the interdependence of genre and disciplinary conventions, the present study aims to shed light on the use of modal verbs in logistics research papers from the perspective of genre- and discipline-specific norms. Accordingly, it departs from the qualitative and quantitative analysis relating all the occurrences of modal verbs in logistics research papers, while the interpretation of the results focuses on the dichotomy between objective and subjective presentation of claims, the ultimate goals being to draw parallels to discipline-specific conventions and to demonstrate the practical implications of the results.

The semantic analysis of modal verbs will depart from Palmer's three-fold division of modality into epistemic, deontic and dynamic modality, which has gradually established itself as one of the most frequently referenced and used classifications since the author introduced it in his work *Modality and the English Modals* (1990). Another frequently cited classification of modality is Coates' (1983) division into epistemic and root modality, whereby the latter subsumes all non-epistemic meanings. Although many scholars have followed Coates' two-fold division, including Sweetser (1990) and Papafragau (1997), there are also others, including Palmer

(1990, 2001 and 2003), Nuyts (2006), and Fachinetti (2003), who find the distinctions within root modality sufficiently great to justify its breakdown into two separate categories: deontic and dynamic modality. A further distinction between these two modal meanings, both of which relate to the possibility or necessity of actualizing the event expressed by the main verb, is typically recognised as lying in the source of possibility and necessity (Depraetere & Reed, 2006). Thus, in the case of deontic modality, possibility is typically granted (permission), while necessity is typically imposed (obligation) on the basis of some kind of authority, which, as a rule, is "external to the subject of the sentence" (Palmer, 2003: 7), such as a person, a set of rules or a social norm, e.g. "John must go home" (Depraetere & Reed, 2006: 274). In contrast, dynamic modality generally refers to the possibility or necessity of the event arising from the subject of the sentence, e.g. "I can make or break my life myself" (Palmer, 1990: 85) or from general circumstances, e.g. "Signs are the only things you can observe" (ibid., p. 83). Accordingly, deontic modality, as a rule, is interpreted as subjective, while dynamic modality is interpreted as objective. The relation between dynamic and deontic modality, on the one hand, and epistemic modality, on the other, is clearly indicated by Gerhardt (1991), who argues that dynamic and deontic modality gradually shade into epistemic when the event referred to by the main verb loses its anchoring in the subject's agency and the speaker's control, respectively "and begins to be the content of the speaker's beliefs" (Gerhardt, 1991: 536 [as cited in Choi, 2006: 156-157]). Besides shedding important light on the relation between dynamic, deontic and epistemic modal meaning, Gerhard's observation that epistemic modality is anchored in the speaker's or writer's belief thus also indicates the markedly subjective nature of epistemic modality. As such, the latter is typically interpreted as the expression of the speaker's or writer's commitment to the truth value of a proposition or judgement that the proposition expressed by the main verb is possible or necessary, one such example being "They may be in the office" (Palmer, 2003: 7). Besides expressing these three univalent modal meanings, modal verbs can also express polyvalent modal meanings. The latter phenomenon has been observed and discussed by various authors, including Coates (1983), Giltrow (2005), Nuyts (2001), and Vihla (1999). Coates' interpretation of such occurrences in terms of modal mergers of two meanings that are "mutually compatible" or, in other words, in a "both/and relationship" (Coates, 1983: 78-79) serves as a starting point for most of the subsequent studies on this phenomenon. Some examples of modal mergers evidenced in previous research include the epistemic/deontic merger with OUGHT TO (Coates, 1983), the deontic/dynamic merger with MUST (Giltrow, 2005) and the epistemic/dynamic merger with MAY (Vold, 2006).

All these meanings substantially shape the textual voice of research papers, in the framework of which they can be further defined by communicative functions specific to this academic genre. One such function, typically related to epistemic modality, is hedging or "the mitigation of claims" (Hyland, 1998: 2; Vold, 2006: 62). As recognised by Hyland (1996: 434 and 436), this plays a critical role in research papers by shaping the textual voice in such a manner as to introduce new knowledge with appropriate "accuracy, caution and humility." In effect, this helps authors to gain ratification for their claims and to persuade their readers. In recognition of its importance in research paper writing, hedging has been studied by several authors, including Hyland (1996), Silver (2003), Vold (2006) and Vázquez and Giner (2008). Modal verbs typically associated with this communicative function are COULD, MAY, MIGHT and SHOULD (Hyland, 1996), and MAY has been recognised as a prototypical example of a

modal used for hedging. One example of MAY used as a hedge can be found in the following sentence: "This increase may well play a significant role in regulating the phosphorylation of PEPc" (Hyland, 1998: 119). The other two modal meanings, i.e. dynamic and deontic meaning, also play an important role in research paper writing. The first is typically used by authors to distance themselves from claims they make by constraining the possibility or necessity of a proposition by external circumstances and thus reporting claims objectively rather than subjectively. Unlike dynamic modality, deontic modality is typically regarded as subjective, especially when the author's authority is used as a constraining factor. Since this use may be perceived as face threatening to readers, the authors of research papers prefer to neutralize their expressions of obligation by constraining them by "shared wants", which, as observed by Giltrow (2005: 182, 189 and 193), are frequently interpreted in terms of social or professional responsibility to act on research findings.

More recent approaches to modality have shown that these modal meanings and their related communicative functions are largely determined by contextual factors (Fachinetti, Krug, & Palmer, 2003). Following the commonly accepted view that modal verbs are polysemous, i.e. they communicate different semantically distinct modal meanings (Depraetere, 2014), these contextual factors can be interpreted in the light of modal restriction which contextually fills the modal's template (ibid.) or, as Kratzer (2013: 7) puts it, epistemic, deontic or dynamic interpretation of a modalised utterance is the result of a merger between "contextually provided modal restriction" and "the common semantic core" of a modal verb. In terms of research paper writing and reading, this means that the author determines in what sense a modal verb is used and how the readers need to recover the intended meaning (Depraetere, 2014), which clearly illustrates the importance of the proper use and understanding of modal verbs in a chosen genre- and discipline-specific context.

Recognizing the critical role of modal verbs in research papers as well as the importance of their proper use and understanding, many scholars have dedicated themselves to the study of the meanings and communicative functions of modal verbs in this academic genre. However, most studies to date have focused on traditional disciplines, either from the field of soft sciences (humanities or social sciences, e.g. literary criticism, sociology and marketing) or from the field of hard sciences (science and engineering sciences, including medicine, biology and engineering) (Hyland, 2008), leaving the field of logistics, which is a relatively young science, as an area that still needs to be investigated in this respect.

The roots of logistics as a science date back to the 1970s, when it began to emerge as a cross-disciplinary field combining a wide range of other disciplines, typically including mathematics, engineering, organisation sciences, business administration and economics (Klaus & Müller, 2012). All of these disciplines have their own perspectives and preferences for their own set of methods, concepts and instruments (ibid.), and accordingly, as proposed by Hyland (2008: 549), can be arranged along the cline of "'hard knowledge' sciences" and "'softer' humanities" with social sciences falling between these two extremes. In 'hard' disciplines, claims are typically accepted "by experimental proof", while in the 'soft' ones they are primarily accepted "on strength of argument" (ibid.). The author further explains that these differences importantly shape the professionally acceptable textual voice (ibid.), which in terms of modality is reflected in a significantly higher frequency of epistemic modality in the humanities (ibid.) and "the preference for [dynamic] modal verbs over cognitive verbs"

in the sciences, since these allow authors to "'objectify the research" (ibid., p. 552). Although Hyland in the case of the natural sciences points out the general preference for modal verbs over cognitive verbs, his further comment that they are employed to objectify the research basically narrows their use down to dynamic use. Hyland's findings on the differences in the use of modal verbs in soft and hard sciences applied to Delfmann et al.'s (2010) observation that logistics as a cross-disciplinary science not only brings together perspectives and methods of both extremes but also develops them further to better suit the specific paradigm, i.e. "the intrinsic elements of the identity", of logistics (Klaus & Müller, 2012: 4-6), could thus imply discipline-specific use of modal verbs in logistics research papers. To see whether and how this is reflected in practice, the present study examines modal verbs in logistics research papers and compares the results to other relevant studies. Following Palmer (1990), the analysis of modal verbs focuses on the central modals CAN, MAY and MUST and the related forms COULD and MIGHT, all of which express possibility and necessity; on OUGHT TO and SHOULD, which formally qualify as modals but are used to express "a facet" of necessity; and on semi-modals – BE ABLE TO, BE BOUND TO, BE GOING TO and HAVE TO/HAVE GOT TO, which formally are out of the system but occupy an important position in the modal system by supplementing or contrasting the modals. Based on a quantitative and qualitative analysis of these modal verbs, this paper aims to answer the following research questions:

Do polysemous modal verbs used in logistics research papers show a preference for any of the three modal meanings and the communicative function(s) related to them?

Does the use of polysemous modal verbs in logistics research papers reflect the dichotomy between objective and subjective presentation of claims?

Can parallels be drawn between the use of modal verbs in logistics research papers and the markedly interdisciplinary nature of logistics as a science?

3. Methodology

The analysis of modal verbs was carried out on a 102,792-word corpus comprising 16 research papers selected from recent volumes of three peer-reviewed journals in the field of logistics: *International Journal of Logistics Management* (6 papers totalling 41,007 words), *International Journal of Physical Distribution & Logistics Management* (4 papers totalling 22,600 words) and *Journal of Enterprise Information Management* (6 papers totalling 39,185 words). The corpus data excludes tables, figures, notes and reference lists.

The analysis was based on a quantitative (simple frequency analysis) and qualitative (semantic) analysis. First, all the research papers were electronically searched through MS Word for the modals CAN, COULD, MAY, MIGHT, MUST, OUGHT TO and SHOULD and the semi-modals BE ABLE TO, BE BOUND TO, BE GOING TO and HAVE TO/HAVE GOT TO. After performing the manual coding of each modal verb with MS word, the concordance programme AntConc (http://www.laurenceanthony.net/software.html) was used to confirm the data. Then, a simple frequency analysis was used to determine absolute and normalised frequencies of modal verbs in logistics research papers. In the next step, all the occurrences were semantically analysed in their context of use and classified according to their meaning as epistemic, deontic or dynamic. The context within which occurrences were classified through the use

of paraphrases and independent modal expressions, e.g. adverbs and verbs (Brewer, 1987; Giltrow, 2005; Leech, 1987; Palmer, 1990 and 2003; Vold, 2006), was a sentence or, when necessary, even a full paragraph or a complete section, as proposed by Piqué-Angordans et al. (2002). Finally, further semantic analysis was applied to determine typical communicative functions of individual modal verbs in logistics research papers.

4. Results

The initial count of modal verbs in logistics research papers was carried out to determine their absolute frequencies and to calculate their normalised frequencies per 100,000 words. Table 1 shows the results of this qualitative analysis alongside the subsequent semantic analysis of the modal verbs included in the study. Absolute frequencies and normalised frequencies per 100,000 words for each modal, as well as absolute (f) and relative frequencies (f%) of different modal meanings for each modal verb are also included. The modals and semi-modals are listed and discussed in descending order of frequency.

	Absolute frequency	Items per 100,000 words	Logistics research papers 102,792 words		
MODALS			MODALITY	f	**f%**
can	368	358	dynamic - neutral	318	**86.4**
			dynamic - subject oriented	50	**13.6**
should	152	148	epistemic	6	**3.9**
			dynamic	42	**27.6**
			deontic	34	**22.4**
			epistemic/dynamic	2	**1.3**
			deontic/dynamic	68	**44.7**
may	126	123	epistemic	63	**50.0**
			dynamic	37	**29.4**
			deontic	1	**0.8**
			epistemic/dynamic	25	**19.8**
could	94	91	epistemic	11	**11.7**
			dynamic	71	**75.5**
			epistemic/dynamic	12	**12.8**
must	41	40	epistemic	1	**2.4**
			dynamic	17	**41.5**
			deontic	11	**26.8**
			deontic/dynamic	12	**29.3**
might	26	25	epistemic	11	**42.3**
			dynamic	11	**42.3**
			epistemic/dynamic	4	**15.4**

ought to	1	1	dynamic	1	**100**
S E M I - MODALS					
able to	38	37	dynamic	38	**100**
bound to	0	0	/	/	**/**
have to	21	22	dynamic	21	**100**
going to	1	1	dynamic	1	**100**

Table 1. Modal verbs and their modal meanings in logistics research papers

A brief overview of the results in Table 1 shows that modals, including CAN, COULD, MAY, MIGHT, MUST, OUGHT TO and SHOULD, occur much more frequently than the semi-modals ABLE TO, BOUND TO, HAVE TO and GOING TO. Further comparison of the frequencies of modals shows that CAN is by far the most frequently used modal and occurs more than twice as often as SHOULD, which ranked second. The verbs which follow, namely MAY, COULD, MUST, MIGHT and OUGHT TO, show a steady and constant decline in their frequency of use, while OUGHT TO is used only once. As already mentioned, semi-modals are used much less frequently than modals, with ABLE TO ranking in first place and HAVE TO in second. GOING TO is also used, but only once, while BOUND TO does not occur at all.

Now, further quantitative and semantic analysis will depart from CAN as the most frequently used modal. A more detailed review of the results shows that the positive form, which according to Palmer (1990) can only be used for the expression of dynamic and deontic modality, by far outnumbers the negative forms *can't* and *cannot* (344 out of 368 occurrences). Subsequent semantic analysis of the logistics research papers included in this study further revealed that positive forms are used exclusively for the expression of dynamic modality; more precisely, 318 out of 368 occurrences are used for the expression of neutral possibility, while the remaining 50 occurrences combine both ability and possibility. In terms of objectivity and subjectivity, both uses, however, allow the writer to distance himself/herself from the expressing of possibility (Lewis, 1986) and thus to report claims objectively rather than subjectively. The following sample sentences from the corpus offer examples of the dynamic neutral possibility use of CAN:

[1] Firms can utilize[1] a variety of approaches to plan for and mitigate supply chain risk. (Cantor, Blackhurst, Pan, & Crum, 2014: 202)

[2] By deferring the full commitment, a firm can limit its exposure to a technology which may turn out to have little value. (Lu, Goh, Garg, & De Souza, 2014: 24)

Examples [1] and [2] show that, with neutral possibility, the enabling factors, which are

1 The underlining of the modal verb and related main verb is ours and will be used henceforth in all sample sentences.

typically external, may or may not be identified. When, as in sentence [1], they are not, CAN is typically used to imply that nothing prevents the action referred to by the main verb from taking place. When, on the other hand, they are specified, they most frequently define circumstances enabling the action. All in all, whether specified or not, enabling factors external to the writer(s), allow for an objective and more or less faceless presentation of claims. Further objectification, however, can be achieved through the use of passive voice. This use, as observed by Coates (1983: 96) and Biber, Johansson, Leech, Conrad, & Finegan (1999: 499), is typical of academic discourse. Accordingly, the combination of CAN and passive voice proved to be frequent in occurrence in our logistics research papers (166 out of 368 occurrences), an example being:

[3] Non-response bias can be described as the result of people who respond to a survey being different from sampled individuals who did not respond, in a way relevant to the study (Dillman, 2007). (Clottey & Grawe, 2014: 414)

Although used much less frequently than the combination of CAN and passive voice, the association of dynamic CAN with the expression *how* also merits inclusion in the present discussion, as it is commonly used to express objective judgment about the degree of possibility (Palmer, 1990: 84). This use was recorded in 18 occurrence of CAN, one of them being:

[4] The shift in the business paradigm has moved the research emphasis to one of SCA, where the current need is to better understand how firms can develop this crucial capability. (Gligor & Holcomb, 2014: 161)

Alongside the predominant sense of neutral possibility for CAN, there is another frequently occurring use of this modal verb, i.e. expressing ability (50 occurrences out of 368 occurrences), which, as argued by Coates (1983), typically refers to properties inherent to the subject of the sentence. However, as pointed out by Leech (1987) and other linguists, ability always additionally implies (neutral) possibility. Although this subject-oriented possibility typically occurs with animate subjects (ibid.), it can also be used with inanimate subjects, with which it is used to indicate "the necessary qualities or power" of the inanimate subjects (Palmer, 1990: 85). The latter use is more frequent in written discourse, especially when such discourse is formal in nature, and frequently observed in the present corpus (45 out of 50 examples of subject oriented possibility). Examples for ability with both animate [5] and inanimate [6] subjects are given below:

[5] Support group comprised of business and change specialists who can develop a plan of how the changes will be communicated with the business. (Poonam & Atul, 2014: 440)

[6] The AHP is one of the more popular and suitable approaches used in the supplier selection domain (Muralidharan et al., 2002) since it can analyze divergent qualitative and quantitative information and evaluate suppliers objectively. (Arpan & Ashis, 2014: 338)

The semantic analysis of all the occurrences of CAN in this study showed that dynamic modality is the only type of modality used for this modal in the corpus of logistics research papers. These findings therefore allow us to believe that this normally polysemous modal verb plays an exclusively dynamic role in logistics research papers, allowing the writers to downplay their subjective role and thus "objectify" their research (Hyland, 2008: 552).

The second most frequently used modal in the corpus is SHOULD. SHOULD is polysemous and can be used to express dynamic, epistemic and deontic modality. As pointed out by Palmer (1990: 59-60), SHOULD often displays indeterminacy between dynamic and epistemic meaning, arising from the fact that if "it is reasonable for an act to take place" it may be equally reasonable "to expect that it will". In this corpus, the occurrences of SHOULD, in which these two modal meanings overlap, were categorised as epistemic/dynamic modal mergers. Occurrences in which circumstantial necessity (i.e. dynamic modal meaning) blends with the subject involvement characteristic of deontically modalised statements were, on the other hand, categorised as deontic/dynamic mergers. The latter proved to be the most frequently used modal meaning of SHOULD (68 out of 152 occurrences) and can, for example, be found in the following sample sentence:

[7] So it can be concluded that ERP implementing hospitals should have an effective PM strategy to control the implementation process, avoiding overrun of budget and ensuring implementation on schedule. (Poonam & Divya, 2014: 416)

The second most frequently expressed modal meaning of SHOULD is dynamic neutral possibility (42 out of 152 occurrences), whereby possibility is constrained only by external factors. One such example is as follows:

[8] In order to have strong support that non-response bias is indeed not an issue, all the statistical tests should result in the correct non-rejection of their respective null hypothesis. (Clottey & Grawe, 2014: 418)

Although not typically dynamic, another occurrence worthy of attention is SHOULD with speech-act verbs. Such occurrences, as Vihla points out (1999: 32), differ from typical circumstantial necessity by not referring to the physical world described but by being used "to indicate rhetorical emphasis". Two such occurrences were identified in logistics research papers, one of them being:

[9] However, it should be noted there is less time allocated to IT, as it is more expensive to address, but it more rapidly makes contributions to performance level. (Ying, Colin, & Mahmood, 2014: 373)

Deontic meaning ranked as the third most frequently expressed modal meaning with SHOULD (34 out of 152 occurrences). Giltrow (2005: 171) observes that in this use SHOULD often expresses obligation "to pursue knowledge" or "take action in the world", whereby subject involvement rather than being performative categorises these occurrences as deontic (Palmer, 1990). Sentences with deontic SHOULD used for the expression of obligation to pursue knowledge typically cluster towards the end of research papers. An example is:

[10] In future research, additional strategic issues should be examined. (Förster, Keller, Gracht, & Darkow, 2014: 392)

SHOULD can also be used epistemically for the expression of the author's subjective judgement, which demonstrates another useful resource for voicing the author's tentative or reasonable assumption based on facts (Coates, 1983; Palmer, 1990) and could thus also be classified as a hedge. Coates' (1983: 64) reference to this use as "its most normal", despite the fact that it proved by far outnumbered by deontic use in the corpus used in her own study,

lends further support to its importance. In the present corpus, too, this epistemic use is far less common than the first three uses (6 out of 152 occurrences) and can be found in this sample sentence [11]:

[11] Thus it should be possible to improve existing measures and analyses of risk, which could increase the efficiency and effectiveness of supply chain and logistics management. (Vilko, Ritala, & Edelmann, 2014: 3)

The least frequently used modal meaning for SHOULD is the epistemic/dynamic merger (2 out of 152 occurrences) in which the author's subjective judgement blends with circumstantial necessity, as demonstrated below:

[12] The cities are physically taking re-development because of urbanization. In the end, the cities should be well developed. (Liu, 2014: 409)

An overview of all modal meanings expressed by SHOULD shows that the authors of logistics research papers predominantly use it for the expression of professional responsibility to either pursue knowledge or act on research findings neutralised by responsibility arising from external circumstances, i.e. deontic/dynamic meaning, whereby the subjectivity typical of deontically modalised utterances is neutralised by the objectivity typical of dynamic modality. This use is closely followed by the univalent expression of either of these two meanings, while epistemic and epistemic/dynamic meanings are used far less frequently. All in all, the observed use of SHOULD shows that the complexity of this modal is also mirrored in a combination of its subjective and objective use, which either overlaps in deontic/dynamic and epistemic/dynamic modality or complements or contrasts one or the other when used with univalent deontic and epistemic expressions, on the one hand, and dynamic ones, on the other. Accordingly, the overall results show more or less equal use in terms of subjective and objective voicing of the necessity of the action referred to by the main verb.

The modal verb MAY proved to be the third most frequently used modal in these research papers. Its polysemous nature and related complexity have been discussed by a variety of authors, including Facchinetti (2003), Palmer (1990) and Vold (2006). In addition, Facchinetti (2003) and Palmer (1990) pointed out its specific use in scientific texts, in which authors frequently use it to constrain their clams by objective data rather than their "subjective appreciation of the proposition" (Fachinetti, 2003: 305) and thus to distance themselves from their claims. The analysis of MAY in logistics research papers showed that it is used for all three modal meanings, i.e. epistemic, dynamic and deontic, as well as a combination of epistemic and dynamic use. Epistemic use, in which MAY is used by authors to signal their subjective attitude towards the proposition (ibid.), proved to be the most frequent in the corpus (f%= 50) and is demonstrated in the following sentence:

[13] Therefore, the measures derived from such assessments may well be based on subjective beliefs, and thus should be treated as such. (Vilko et al., 2014: 14)

As established in the introduction, this use is associated with hedging, which is frequently employed by research paper writers to express new claims with due caution and in so doing, to avoid or at least minimise the readers' opposition. The intent, however, is still to signal the author's persona and engage with the readers.

While epistemic use is a frequent use of MAY in a broader sense, its dynamic use is more specific to scientific texts, where authors frequently use it to detach themselves from their claims by reporting them objectively, i.e. as constrained by external factors rather than subjective judgment. The dynamic use of MAY is its second most frequent use in the corpus (f%= 29.4) and can, for example, be found in the following sentence:

[14] This study demonstrates how different decision support theories based on the AHP may be applied for group decision making. (Arpan & Ashis, 2014: 346)

With MAY, subjective qualification of the author's commitment to the truth value of a proposition can also overlap with circumstantial possibility, as observed by Palmer (1990) and Vold (2006). Another important finding relevant to research paper writing is Coates' (1983) observation that in her corpus this use of MAY does not occur in spoken discourse but usually in more formal written texts. In logistics research papers, 25 out of 126 occurrences of MAY exhibit overlapping of epistemic and dynamic possibility, one typical example being:

[15] Poor consultant effectiveness and poor PM effectiveness can lead to a low quality of BPR and the business processes may match poorly with the ERP systems, resulting in implementation failure. (Poonam & Divya, 2014: 405)

There is also one example of the deontic use of MAY:

[16] The finding of this study may not be generalized for other geographic areas. (Poonam & Atul, 2014: 441)

Here, the negative form *may not* is used by the authors to express their refusal of permission to generalise the study's finding, whereby the deontic force is reduced by the use of the agentless passive.

To sum up, the results show that epistemic modality is the most frequently used modality with MAY, followed by dynamic use and a merger of epistemic and dynamic modality. The results for MAY thus confirm a preference for one modal meaning, that is epistemic, which is typically associated with the subjective expression of the author's stance towards his/her claims. Dynamic use typical of scientific discourse (Fachinetti, 2003; Palmer, 1990), on the other hand, occurs less frequently and is employed by the authors to show that their claims are based on objective data rather than their personal view.

COULD was ranked the fourth most frequently used modal in the corpus. Like MAY, it is used to express epistemic, dynamic and epistemic/dynamic modality, with dynamic modality being the most frequently occurring modal meaning (f%= 75.5). When used dynamically, COULD, similarly to CAN, is used for the expression of neutral or subject-oriented possibility, with the main difference being that with COULD these two meanings are either past or hypothetical (Coates, 1983), as demonstrated in the two examples from the corpus:

[17] For example, CopyMagic, a copier manufacturer in Europe, successfully initiated remanufacturing in-house with a high percentage of lease contracts for its products. The company could predict the return flows of used products quite accurately. (Lu et al., 2014: 23)

[18] Therefore, a firm is likely to feel pressure from both internal stakeholders and external stakeholders to disseminate knowledge regularly so that it can minimize sources of supplier risk that could negatively impact a firm's operational and financial performance. (Cantor et al., 2014: 206)

In example [17], "could predict" refers to past possibility, which is related to the remanufacturing process, whose initiation is also set in the past. Unlike COULD in example [17], COULD in example [18] is used to express hypothetical possibility, which in this respect may be contrasted with "can minimize" in the preceding sentence. The comparison of these two occurrences, "can minimize" and "could negatively impact", clearly indicates that with the latter there is "a little less certainty about the possibility" (Palmer, 1990: 58) than with the former.

Unlike CAN, COULD can also be used to express epistemic possibility (Coates, 1983; Gresset, 2003). In the corpus this use of COULD is the lowest (f%= 11.7) but nevertheless important because COULD might, as suggested by Coates (1983: 167), become "the new exponent of tentative epistemic possibility" used instead of MIGHT, which is increasingly becoming synonymous with MAY. The epistemic use of COULD functioning as a hedge can be found in the following example:

[19] Taking changes in value chains into consideration, disruptive innovations or new production technologies could encourage companies to impart broad skills to employees and train them how to adjust to changes. (Förster et al., 2014: 430)

In the present corpus there are also instances in which dynamic possibility overlaps with an epistemic judgement (f%= 12.8), one such example being:

[20] Defining any specific task for adoption in the proposed questionnaire could reduce the response rate in terms of adoption. (Mahmud, Vinod, Uma, & Yogesh, 2014: 398)

The results in Table 1 show that possibility constrained by external circumstances, i.e. dynamic modality, is the prevailing type of modality with COULD, which is also used to express epistemic/dynamic and epistemic modality. With this, the assumption of a preference for one modal meaning is again confirmed and COULD is recognised as a modal verb primarily used for objective reporting of findings.

The modal verb MUST was ranked the fifth most frequently used modal in the corpus (f= 41) and is used for the expression of all three modal meanings and the deontic/dynamic merger. Most frequently (f%= 41.5) it is used by research paper authors to objectively report research findings, i.e. as constrained by external factors. When used deontically (f=26.8), the essentially face-threatening nature of this modal meaning is typically neutralised by constraining the obligation to act on research findings by collective professional responsibility rather than the author's authority (Giltrow, 2005). Occurrences in which constraining factors arising from professional authority overlap with external necessity were classified as deontic/dynamic mergers (f%=29.3). There is also one occurrence in which MUST is used epistemically to express the author's judgement of the possibility of the truth value of a proposition (f%=2.4).

The results for MUST show that it is used polysemously, occurring most frequently with dynamic modality. Nonetheless, although used less frequently, deontic modality also contributes

substantially to the interpersonal nature of research paper discourse by connecting with the professional community, which it predominantly addresses. The prevailing objective use of modal verbs is thus complemented by subjective expression of obligation.

The next modal is MIGHT, which is used 26 times, with modal meanings being distributed between epistemic (f= 11), dynamic (f= 11) and epistemic/dynamic (f= 4) meanings. The distribution of modal meanings shows that authors use MIGHT equally frequently for the epistemic expression of subjective judgement and dynamic expression of objective evaluation of possibility, which counters the assumption of a preference for one modal meaning.

The modal OUGHT TO occurs once and is used to express dynamic modality. Owing to its low frequency of occurrence, no other conclusions can be drawn for this modal verb.

Regarding semi-modals, Table 1 shows that in the corpus of logistics research papers these are used much less frequently than modals, with 38 instances of ABLE TO, 21 of HAVE TO and 1 instance of GOING TO. All occurrences of these three semi-modals demonstrate dynamic use only, which supports the assumption of the prevalence of one type of modality and shows that semi-modals typically contribute to the objective nature of logistics research papers.

To sum up, based on the results of the quantitative and semantic analysis, it can be concluded that the majority of the analysed modal verbs used in the corpus of logistics research papers show a preference for one modal meaning, typically dynamic, since only MAY shows a preference for epistemic modality. MIGHT and SHOULD, however, proved the only modals showing no particular preference for any of the three basic modal meanings, the former by showing equal use of epistemic and dynamic meaning and the latter by showing preference for a polyvalent modal meaning, i.e. deontic/dynamic modality. The evidenced distribution of modal meanings and related communicative functions thus shows that the authors of logistics research papers predominantly use modal verbs to distance themselves from their claims by reporting them objectively, while employing them far less frequently for subjective qualification of statements, on the one hand, and expression of obligation to pursue knowledge or to act on research findings, on the other.

5. Discussion

In line with the commonly accepted view that research paper writing is characterised not only by genre-specific but also by further discipline-specific use of various linguistic elements (Bhatia, 2002; Hewings, 2006; Hyland, 2005; Vázquez & Giner, 2008), including modal verbs and the modal meanings they express, the present study has focused on the analysis of modal verbs and their modal meanings in research papers in the field of logistics. Since the latter is recognised as a science that combines perspectives and methods from the soft and hard sciences and develops them further to suit discipline-specific needs and conventions, the more specific goal of the study has been to shed light on how this is reflected in the use of modal verbs and what practical implications the results could have for students and researchers in the field of logistics. This line of research also relates to the practical side of logistics, which, as recognised by Naim et al. (2000: 78), has become “an important industry-relevant discipline”, which in effect has led to a greater need for “highly qualified, cross-disciplinary aware professionals” who are able to “bridge the gap between the ‘soft’ system

issues and the 'hard' engineering requirements that characterize any logistical problem". In the light of this recognition, research paper reading and writing could also be seen as a logistical problem or challenge that students and researchers in the field of logistics face in their study and/or research and related reading and writing skills, as an important link between theoretical and practical approaches to logistical issues. Such a view significantly contributes to highlighting the importance of well-informed academic reading and writing, which can be promoted by providing an insight into the discipline-specific use of linguistic features typically used for shaping the textual voice of research papers. Accordingly, the present study has set out to explore not only how modal verbs are used in logistics research papers but also how they contribute to bridging the gap between the soft and hard sciences forming the interdisciplinary field of logistics.

The results of the present study, which employed a combination of quantitative and semantic analysis of modal verbs, confirm that most polysemous modal verbs show a preference for one modal meaning, typically dynamic. The modal verbs MIGHT and SHOULD, however, are the only two modals showing no outstanding preference for any of the three modal meanings, while by being predominantly used for the expression of epistemic modality, MAY stands out as the only modal verb showing preference for a modality other than the dynamic one. In terms of communicative functions, the prevailing dynamic modality, which was used as the only meaning (with CAN), or as the most frequently used one (with COULD, MUST, OUGHT TO and ABLE TO), is primarily used when authors want to minimize their role in the process and let the facts speak for themselves instead, which results in the possibility being constrained either by external factors (with neutral or circumstantial possibility) or by factors inherent to the subject of the sentence (ability). Epistemic and deontic modality, on the other hand, although used much less frequently, in terms of communicative functions significantly complement dynamic modality by emphasising the writer's persona through the expression of subjective qualification of statements and by directing the readers to engage with the presented knowledge and findings, respectively. Besides being used as univalent modal meanings, both epistemic and deontic modality also occur in combination with dynamic modality, whereby the author's professional authority as a constraining factor either overlaps with or is neutralised by factors external to the authors, which in effect makes respective utterances more factual (i.e. epistemic/dynamic mergers) or less face threatening (i.e. deontic/dynamic mergers). The latter, i.e. deontic/dynamic merger, proved the most frequent modal meaning with SHOULD, which thus negates the general assumption of a prevalent univalent modal meaning in modal verbs. In terms of communicative function, the observed epistemic use of MAY, MIGHT, COULD and SHOULD deserves special attention. It performs an important function in negotiating claims and persuading the readers (A. Hewings & M. Hewings, 2001) and has as such been referred to as hedging or mitigation of claims. This epistemic use occurred most frequently only with MAY, while in the case of MIGHT, i.e. another modal typically associated with hedging, it turned out to be only one of the most frequently used meanings, the other one being dynamic meaning.

As to our second research question, the observed prevalence of dynamic modality, on the one hand, and a relatively low use of epistemic and deontic modality, on the other, could be interpreted as the dichotomy between the prevailing objective and less frequent subjective reporting of claims. By systematically resorting to dynamic modalisation of their statements, authors can depersonalize their writing and keep the tone objective and unmarked (Giltrow,

2005: 173); conversely, when employing epistemic and deontic modality, they can personalize their writing by signalling their subjective opinions or directing the readership towards a prescribed course of action.

Finally, departing from Bhatia's (2002) view on the interdependence of genre and disciplinary conventions, we suggest that the evidenced dichotomy between the objective (dynamic) and subjective (epistemic and deontic) reporting of claims could be interpreted not only in terms of the more recent view on effective research paper writing, which advises the authors to combine the traditionally preferred objectivity with the expression of their stance, but also in terms of the epistemological opposition between hard and soft sciences, since logistics as a cross-disciplinary field combines perspectives and methods of both extremes. In hard sciences, claims are typically accepted "by experimental proof", while in soft disciplines they are primarily accepted "on strength of argument" (Hyland 2008: 549), which in terms of modality implies the observed dichotomy between the objective and subjective modalizing of statements. However, since the present study focused on the analysis of modal verbs in logistics research papers, we can only assume that the evidenced dichotomy is related to both genre and discipline conventions, while further research comparing modal verb use in logistics and related disciplines (e.g. mathematics, social sciences and economics) should be undertaken to confirm our assumption.

All in all, based on the fact that research papers have been recognised as a key resource for familiarising students with new knowledge claims and discipline-specific "characteristics and conventions" (Hewings, 2006: 9) and the evidenced use of modal verbs in logistics research papers, it seems advisable that ESP courses for students of logistics should in their instruction on the use of modal verbs, besides focusing on their communicative functions in more general contexts, pay special attention to their use and function in logistics research papers. Accordingly, we suggest that ESP courses for logistics should include tasks based on authentic research papers on logistics, which would first of all raise the students' awareness of modal verb use in this disciplinary genre as well as familiarise students with the three basic functions evidenced also in the present study: objective reporting of claims, subjective qualification of the author's commitment to his/her statement, as well as subjective expression of permission or obligation to act on research findings. In terms of step-by-step instruction, we suggest that students should first be pre-taught the lexical forms and related meanings of modal verbs in the context of logistics research papers, establishing parallels to their use and function in a more general context already familiar to them. In the next step students could be given a sample research paper and be asked to identify all the occurrences of the modal verbs and categorise them according to their function in the three categories mentioned above (here we decided to avoid the notions dynamic, epistemic and deontic, since these may sound too abstract to students and decided to use function descriptions instead). Finally, students could be given a task based on extracts from different parts of authentic logistics research papers, from which modal verbs have been omitted and be asked to fill the gaps with the modal verb they find most appropriate. The list should be limited to the eight modal verbs that proved most frequent in the corpus of logistics research papers in the present study: the modals CAN, COULD, MAY, MIGHT, MUST and SHOULD and the semi-modals HAVE TO and ABLE TO. The given task could thus help raise students' awareness of the role played by modal verbs in shaping the textual voice of research papers in a manner that will provide for effective

transmission of new knowledge and findings, on the one hand, as well as introduce students to genre- and discipline-specific use of modal verbs. Besides raising the students' awareness of discipline- and genre-specific use of modal verbs in logistics research papers, the results of our research should also prove useful to researchers in the field of logistics, since mastery of discipline-specific rhetorical conventions has been recognised as playing a decisive role in becoming and remaining a member of the international academic community (Vassileva, 1997).

6. Conclusion

The semantic and quantitative analysis of modal verbs and related modal meanings in the corpus of logistics research papers yielded results consistent with the view that academic writing is characterised not only by its objective presentation of new knowledge and findings, but increasingly by a combination of objectivity and subjectivity. The latter can be interpreted as either the "sociality of knowledge", that is, its "production and reception" (Giltrow, 2005: 172) or as the process by which authors put forward their views for scrutiny by their fellow researchers (Hewings, 2006) and engage with them as members of the scientific community (Hyland, 2005: 173).

Following Bhatia (2002) and other scholars who argue that disciplinary variations complement genre-based use of language, it could be inferred that the dichotomy between objective and subjective use of modal verbs evidenced in logistics research papers is both genre-specific, i.e. specific to research papers, as well as discipline-specific, i.e. specific to logistics. Accordingly, it could be further argued that ESP courses for students of logistics, who will not only read but oftentimes also write logistics research papers, should in their instruction on the function of modal verbs pay special attention to their use in logistics research papers and equip students with the knowledge necessary for their proper interpretation and use in this disciplinary genre.

The main goal of the present study was to provide an insight into the use of modal verbs in logistics as a cross-disciplinary field, which is why the semantic analysis was limited to logistics research papers. However, to provide further evidence of the discipline-specific use of modal verbs in logistics, future research should analyse and compare modal verbs and their communicative functions in research papers in logistics and the disciplines from which it emerged, for example mathematics, social sciences and economics. Another possible future avenue for study is the use of modal verbs across the three main sections of research papers, i.e. introductions, methods, results and discussions, as well as their use in abstracts as "independent entities" detached from research papers (Hewings, 2006: 12).

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Appendix A: The corpus

A. *International Journal of Logistics Management* (41,007 words)

Azzi, A., Battini, D., Faccio, M., Persona, A., & Sgarbossa, F. (2014). Inventory holding costs measurement: a multi-case study. *International Journal of Logistics Management, 25*(1), 109–132.

Cantor, D. E., Blackhurst, J., Pan, M., & Crum, M. (2014). Examining the role of stakeholder pressure and knowledge management on supply chain risk and demand responsiveness. *International Journal of Logistics Management, 25*(1), 202–223.

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Lu, Q., Goh, M., Garg, M., & De Souza, R. (2014). Remanufacturing in Asia: Location choice and outsourcing. *International Journal of Logistics Management, 25*(1), 20–34.

Tacken, J., Sanchez Rodrigues, V., & Mason, R. (2014). Examining CO2 reduction within the German logistics sector. *International Journal of Logistics Management, 25*(1), 54–84.

Vilko, J., Ritala, P., & Edelmann, J. (2014). On uncertainty in supply chain risk management. *International Journal of Logistics Management, 25*(1), 3–19.

B. *International Journal of Physical Distribution & Logistics Management* (22,600 words)

Clottey, T. A., & Grawe, S. J. (2014). Non-response bias assessment in logistics survey research: Use fewer tests? *International Journal of Physical Distribution & Logistics Management, 44*(5), 412–426.

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Liu, X. (2014). China-based logistics research: A review of the literature and implications. *International Journal of Physical Distribution & Logistics Management, 44*(5), 392–411.

Tate, W. L., Ellram, L. M., & Dooley, K. J. (2014). The impact of transaction costs and institutional pressure on supplier environmental practices. *International Journal of Physical Distribution & Logistics Management, 44*(5), 353–372.

C. *Journal of Enterprise Information Management* (39,185 words)

Arpan, K. K., & Ashis, K. P. (2014). How can a group of procurement experts select suppliers? An approach for group decision support. *Journal of Enterprise Information Management, 27*(4), 337–357.

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