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A CORPUS-BASED ANALYSIS OF LEXICAL VERBS IN L2 PROFESSIONAL ENGINEERING WRITING

Radina Mohamad Deli[1+]
Chuah Kee Man[2]
Nur Tahirah Razali[3]

[1,2,3]*Universiti Malaysia Sarawak, Malaysia.*
[1]*Email: mdradina@unimas.my*

(+ Corresponding author)

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ABSTRACT

This study focuses on the use of English lexical verbs in the writings of Malaysian professional engineers. The research objectives were to: (1) identify frequently used lexical verbs in written engineering texts, (2) determine whether these frequent verbs are highly relevant for engineering, and (3) whether the verbs are technical or non-technical in nature. A total of 20 written texts consisting of official reports, 'pass down' instructions and memos from the fields of electrical, electrical and mechanical engineering were collected. The texts were contributed by non-native English speaking Malaysian engineers from various Malaysian-based companies. The annotated data was analysed using the AntConc 3.5.7 software. All verb forms were found to be used in texts namely the base, the infinitive, the past tense, the third person singular simple present tense, the present continuous and the past participle forms. The corpus contained the highest number of lexical verbs in the base form compared to the singular simple present form which had the lowest occurrence. A further analysis showed that the base form was used in the imperative to relay task instructions to peers or subordinates, while the singular present form may correlate with the infrequent usage of the active form in engineering texts. Of all 30 frequent verbs in the top 5 for each verb form, only eleven can be considered as highly relevant for engineering despite their non-technical nature. The results further suggest that overlaps exist between commonly used non-technical verbs in academic and professional engineering writing.

Contribution/ Originality: This study is one of the very few studies that have investigated L2 professional engineering writing with a focus on lexical verbs using the corpus methodology.

1. INTRODUCTION

Over the last few decades, corpus-based research on professional discourse has been widespread due to the advancement of corpus technology and heightened interest in the language of professionalism. Business, engineering and legal communication, among others have been sparking interest because of the ever-increasing importance of these fields in today's world and the accompanying crucial communication transactions taking place in the professional setting. On a large scale, a number of corpora have been progressively developed to represent professional English in general such as the PERC Professional English Research Consortium (2008-2016) with a total of 17-million words gathered from academic journal texts from various fields, and the Cambridge Business English Corpus, a huge 200-million word collection of British and American business language both in spoken and

written forms. For the engineering field, a few language corpora have been built and amongst the most notable and comprehensive are the Hong Kong Engineering Corpus (Cheng, 2010) and the Hong Kong Corpus of Surveying and Construction Engineering (HKCSCE). These are examples of extensive corpora dealing with written Engineering English as used by professionals. The former is a massive collection of texts from Hong Kong's engineering sector with a total of 9,224,384 words while the latter is one of its many subs that focus on surveying and construction engineering texts which comprises 5,707,871 words. These were mainly developed to empower professionals-in-training to be familiar with the kinds of writing used in the industry. A more specific instance of a professional language corpus containing a considerably smaller number of words of 400,000 would be the Guangzhou Petroleum English Corpus or GPEC (Qi-bo, 1989) which was created to investigate the features of petroleum English as used in Guangzhou. In the Malaysian context, at least one professional engineering corpus has been developed namely the Corpus of Engineering Written Industrial Communication or the COREWIC (Manvender *et al.*, 2012) which compiled engineering work procedures from three Malaysian companies in the petroleum industry totalling 65, 612 words.

Comparatively, more corpus-based research has been done on academic engineering language involving textbooks or reference books (see (Mudraya, 2006; Ng *et al.*, 2013; Shamsudin *et al.*, 2013)) and students' language production (see (Winder *et al.*, 2017; Radina and Chuah, 2019)). An overarching theme for these research is the need for corpus-mediated language pedagogy and interventions for teaching and learning in engineering studies. This is particularly true in the case of second language education where English is commonly used in teaching the engineering syllabus. The need for such research has largely been prompted by the changing needs of the industry in the 21st century where engineers are expected to be equipped with both technical knowledge and language competence. Having good English communication skills is an important aspect of an engineer's profession and a deficiency in this aspect "undermines the image of an engineer" (Shikha as cited in Sheth (2015)).

One language skill that is not normally associated with engineering and is often underrated by students in the field is writing. Despite this common notion, writing, however, is a skill that is highly sought after by employers, alongside other communication and soft skills. In fact, professional engineers are required to produce different kinds of writing including project proposals, writing emails, reports, and presentation slides, among others (Rajprasit *et al.*, 2014). Unfortunately, some studies have cited writing as an inadequacy for novice engineers in both English native-speaking countries (Koehne, 1995) and non-native speaking countries (See (Yusoff and Samah, 2013; Rajprasit *et al.*, 2014)).

Unlike the huge amount of interest shown towards corpus research on academic engineering writing, the attention given to professional writing has remained minimal. Several studies examined passives and objectivity in workplace engineering texts (McKenna, 1997; Ding, 2001; Conrad and Pfeiffer, 2011; Conrad, 2018) but were conducted mainly within the monolingual English context. Conrad (2018) in particular explored the passivity and impersonal style of writing by students and practitioners in the civil engineering field. Practitioner reports, journal articles and student reports were analyzed and compared using the multimodal analysis approach. Results showed a high occurrence for passives used in the three types of writing. Aside from the focus on passive structures, the number of studies looking into workplace or professional engineering writing has been minimal. Furthermore, investigations on language features of professional engineering writing in the context of English as second language have been very limited. In one particular study, Manvender *et al.* (2012) used various computer-assisted corpus analyses (CACA) including move analysis, sentence level linguistic structural analysis as well as verb form analysis to investigate their COREWIC corpus to demonstrate how these can aid researchers in conducting descriptive linguistic analyses.

One important aspect in technical writing is verb choice which typically involve the selection of certain lexical verbs over others (see Last (2019)). Despite its importance, lexical verbs have remained an underexplored linguistic element in studies involving engineering texts that are either academic or professional in nature. Lexical verbs refer

to main verbs that typically express action, state, and in academic writing, they are mainly responsible for helping to convey some major functions in academic discourse like explaining cause and effects, contrasting and summarising (Granger and Paquot, 2009). Consequently, the lack of knowledge of English Academic Purpose (EAP) verbs is seen as a serious limitation for learners that hinders the expression of thought in all their nuances and expected style (Granger and Paquot, 2009). The same, thus, can be said about the use of lexical verbs for professional or technical purposes. In fact, the choice of verbs may be more crucial in workplace writing as it often involve real-life circumstances, for example communicating specific, clear and accurate information to clients, and maintaining business relationships.

Therefore, this study aims to examine the use of English verbs in the L2 writing of professional engineers. The objectives are as follows:

1) To identify frequently used lexical verbs in written engineering texts,
2) Determine whether these frequent verbs are highly relevant for engineering, and
3) Determine whether the verbs are technical or non-technical in nature.

2. METHODOLOGY

A total of 20 sets of texts written by professional engineers within the fields of mechanical, electrical and electronic engineering were collected as part of an ongoing corpus project involving writings by Malaysian student and professional engineers in specific engineering fields. These scripts comprised of memos, official reports, and unofficial 'pass down' instructions. The 'pass down' instructions are work instructions written by engineers for their peers during work shift handover. These written texts were contributed by non-native English speaking Malaysian engineers who are currently working for various Malaysian-based local and overseas companies. The texts which are either in word or PDF format were converted to plain text for annotation. In order to protect privacy and confidentiality, names of individuals and companies were removed and replaced with initials. Some abbreviations, formulae, as well as complex and repetitive numbers were also eliminated to avoid complexities in the analysis. The data was annotated using the CLAWS4 software part-of-speech (POS) tagger. The POS-tagging for the lexical verbs are shown in Table 1.

Table-1. List of tagging for lexical verb forms.

No	Coding	Example
1	VV0	(base form, e.g. use, refer).
2	VVD	(past tense, e.g. found, closed).
3	VVG	(-ing participle, e.g., causing, running).
4	VVI	(infinitive, e.g. to ensure, to include).
5	VVN	(past participle, e.g. required, based).
6	VVZ	(-s simple present singular form, e.g. follows, increases).

Using the Word List tool in AntConc 3.5.7 software, frequencies of the lexical verbs by verb forms in total was calculated. In addition, lists of the most frequent lexical verbs in each verb form were generated using the Cluster/n-gram tool. The top 5 lexical verbs for each form were then discussed in detail with the help of the Concordance tool that produces collocation lines for words. The frequent verbs will then be compared to an existing word list namely the Academic Keyword List (Paquot, 2010) and the Hong Kong Engineering Corpus (HKEC) (Cheng, 2010). The former contains potential academic words which are found to be infrequent in other kinds of texts, and thus may be used to refer to activities characteristic of academic words. The HKEC, on the other hand, comprises a massive collection of texts from Hong Kong's engineering sector with a total of 9,224,384 words. Finally, the verbs that figured prominently within the study's corpus as well as the HKEC will then be characterised based on a measure or degree of 'technicalness' (Nation as cited in Menon and Mukundan (2010)).

Cowan (1974) and Nation (2001) proposed similar categorisations of the lexis of science which can be summarized as follows (Menon and Mukundan, 2010):

1. Highly technical words – these are words which appear rarely outside its particular field such as 'epithelial' and 'chromosome' in the science and medical fields.

2. Sub-technical words – these are 'context independent' words (Cowan, 1974) which occur with high frequency across disciplines but the majority of their uses with a specific meaning are related to this field. The specialized meaning it has in this field is readily understood outside the field, such as the word 'memory' in the computing field (Nation, 2001).

3. Semi-technical words – these are words which have one or more general English language meanings and which in technical contexts take on extended meanings.

4. Non-technical words – these are words which are common and have little specialization of meaning, for example 'hospital' and 'judge'.

3. RESULTS AND FINDINGS

The frequency analysis done on the corpus revealed that it contained a total of 47985 tokens and 3214 word types. Based on verb form analysis, there was a total of 2436 lexical verbs found in the corpus. All six verb forms were used in the practitioners' writing and Table 2 shows the frequency of each verb form. The verb form with the highest number of occurrences is the base form with 811 counts whilst the form with the lowest occurrence is the singular simple present tense with 134 verbs.

Table-2. Frequency of lexical verb forms.

Frequency	Verb Initials	Type of verb form
811	VVO	Base form (e.g. use, refer).
572	VVN	Past participle (e.g. found, failed).
387	VVI	Infinitive form (e.g. to include, to ensure).
316	VVG	Present continuous '-ing' form (e.g. using, conducting).
216	VVD	Past tense (e.g. closed, conducted).
134	VVZ	Simple present singular '-s' form (e.g. increases, needs).

In the present study, verbs in the base form were not used predominantly following a subject in active sentences such as in 'the machines check for errors'. Instead, the base form was mainly used in the imperative form suggestive of language used for instruction as evidenced in the following sentence 'Check if the structure is intact'. The prevalence of the base form as used in the imperative came from the pass down instructions written by engineers to their peers or subordinates which made up about 40% of the texts collected.

The frequency of the base form at 811 is comparatively higher than that of the past participle, the second most common verb form with only 572 occurrences. This finding is not in line with the findings of Manvender *et al.* (2012) in which the past participle was found to be highest in their COREWIC corpus containing engineering work procedures. In addition, although other studies on workplace engineering texts did not directly quantify and compare verb forms, the use of passive structures has also been shown to be prevalent which would naturally be reflected through the use of the past participle (e.g. (McKenna, 1997; Ding, 2001)). Nevertheless, in one study done by Conrad (2018) which compared student and practitioner writing in civil engineering, although the use of passives was predominant in general, it was found to be higher in the academic setting.

The most infrequent verb form found in the texts is the simple present singular '-s' form with 134 counts. As expected, the use of this verb form may correlate with the use of the active structure which has been found to be uncommon in professional engineering writing. In one corpus study of academic writing involving undergraduates' essay writings in the argumentative genre, the use of the singular '-s' form was found to be predominant to reflect writer's attitude and voice when making arguments (Kanestion *et al.*, 2016). Thus, it can be assumed that the

infrequent use of the '-s' singular verb form may correlate with the style of writing commonly employed in workplace engineering writing which is often claimed to be objective or impersonal (see (Ding, 2001; Conrad, 2018)). Table 3 shows the top five verbs for each verb form. The verbs *refer*, *check*, *use*, *proceed* and *make* were ranked in the top five for the base form. As shown in Table 4, the verb *refer*, was used typically in reference to appendix, tables and images which is very characteristic of workplace writing especially for the purpose of giving instructions to work colleagues as well as for aiding customers or clients in their reading. The word *check* and *proceed* were used mainly for instructing engineers in task execution as exemplified in Table 5 and 6. The verb *use* similarly served this function. *Use* and *proceed* are both listed in the top 200 words of the HKEC signifying their importance in work-related texts. The verbs *refer* and *check*, however, were found to have low occurrences in the HKEC. The two words, nonetheless, were found to be significant in instruction-based texts found in the current study. Finally, *make* which is a general verb commonly used in general English was shown to appear frequently as the phrasal verb *make sure* as seen in Table 7. This verb, however, is not listed as frequent in the HKEC. A synonym of *ensure*, the top most occuring verb in the infinitive form, the phrase *make sure* serves the function of instructing and emphasizing on engineering-related tasks. Out of the five verbs, only *refer* and *use* are listed in the AKL and are often shown to be characteristic of academic writing.

Table-3. Top five verbs in each verb form based on frequency.

No.	VVO	Fr.	VVN	Fr.	VVI	Fr.	VVG	Fr.	VVD	Fr.	VVZ	Fr.
1	Refer	26	Required	26	To Ensure	15	Using	23	Found	27	Shows	14
2	Check	19	Based	23	To Include	12	Causing	10	Closed	21	Increases	6
3	Use	18	Used	19	To Check	10	Running	9	Failed	16	Needs	6
4	Proceed	14	Released	16	To Provide	7	Shaking	8	Passed	15	Moves	5
5	Make	13	Shown	16	To Use	7	Following	5	Forecasted	10	Depends	3

Table-4. Collocations lines for *refer*.

1 Detail_VV0 Duct_NP1 Sizing_NP1 Calculation_NN1 **refer**_VV0 to_II Appendix_NN1 1_MC1
2 Drawing_NN1 of_IO Duct_NP1 Layout_NN1 **refer**_VV0 to_II Appendix_NN1 2_MC 16.0_MC
3 Off_II coil_NN1 air_NN1 temperature_NN1 (_(**Refer**_VV0 to_II Appendix_NN1 3_MC)_)

Table-5. Collocations lines for *check*.

1 ,_, doors_NN2 ,_, partitions_NN2 ,_, etc_RA ._. **Check**_VV0 if_CSW the_AT structure_NN1 is_
2 course_NN1 of_IO action_NN1 (_(eg_REX ,_, **check**_VV0 if_CSW there_EX is_VBZ real_
3 he_AT current_JJ alignment_NN1 ;_; 7.1.3_MC ._. **Check**_VV0 if_CSW any_DD wafer_NN1

Table-6. Collocations lines for *proceed*.

1 NEED_VV0 VERIFICATION_NN1 -PLEASE_RR **PROCEED**_VV0 WITH_IW LPT_NP1
2 IMPLANTERS_NN2 GROUP_NN1)_) PENDING_II :_: -_- **PROCEED**_VV0 TO_TO TRIGGER_VVI QUARTERLY_JJ
3 and_CC process_VV0 module_NN1 ,_, then_RT **proceed**_VV0 with_IW recovery-_NN1

Table-7. Collocations lines for *make*.

1 simple_JJ as_CSA possible_JJ and_CC **make**_VV0 the_AT duct_NN1 runs_VVZ symmetrical_
2 RR recorded_VVN checklist_NN1 ;_; 1_MC1 ._. **Make**_VV0 sure_JJ to_TO record_VVI below_
3 When_CS using_VVG the_AT jig_NN1 ,_, **make**_VV0 sure_JJ the_AT direction_NN1 is_

One interesting thing to note is the predominance of the verb *use* in the practitioners' writing which appeared in the top five list for four verb forms: ranked fifth for the infinitive form (VVI), third for base form (VVO) and the

past participle (VVN), and first for the '-ing' form (VVG). Table 8 shows the collocations for the verb use in the four verb forms. In line with this finding, the verbs *used*, *use*, and *using* are ranked in the top 200 word list for the HKEC. This word list, however, consisted of all parts of speech, and was not analysed and computed based on verb form. This means that the total count of the word *used* for instance may also include the adjectival form of the word, while the count for *use* may include both the noun and verb forms of the word. Nonetheless, the finding from this small corpus can be taken as evidence to show the relevance of the verb *use* in professional engineering writing especially for the purpose of explaining that something such as a tool or a skill is being utilized for a particular task or purpose.

Table-8. Collocations lines for *use, used, using* and *to use.*

Use
1 above_JJ factors_NN2 ._. Many_DA2 designers_NN2 **use**_VV0 a_AT1 simple_JJ square_JJ foot_ 2 _ZZ1 (_(33_MC to_II 60_MC ft/s_FU)_) **Use**_VV0 the_AT maximum_JJ velocity_NN1 limits_ 3 1 drop_NN1 in_II main_JJ duct_NN1. **Use**_VV0 a_AT1 pressure_NN1 drop_NN1 table_
Used
1 The_AT model_NN1 is_VBZ widely_RR **used**_VVN for_IF system_NN1 analysis_NN1 and_ 2 of_IO water_NN1 value_NN1 are_VBR **used**_VVN ._. Water_NN1 value_NN1 provides_VVZ 3 regional_JJ hydro_NN1 system_NN1 isVBZ **used**_VVN to_TO determine_VVI the_AT weekly_ 4 The_AT model_NN1 is_VBZ commonly_RR **used**_VVN for_IF system_NN1 analysis_NN1 ._.
Using
1 _NN2 ._. 2_MC ._. Limited_JJ staffs_NN2 of_IO **using**_VVG SAP_NN1 slow_VV0 down_RP 2 Generations_NN2 for_IF Optimal_JJ Scheduling_NN1 **using**_VVG SINTEF_NP1 EMPS_NN1 3 any_DD transmission_NN1 line_NN1 investment_NN1 **using**_VVG EMPS_NN2 software_NN1 4 has_VHZ developed_VVN EMPS_NN2 model_VV0 **using**_VVG SDDP_NP1 where_CS the_AT
To use
1 the_AT most_RGT practical_JJ to_TO **use**_VVI is_VBZ the_AT CLTD/SCL/CLF_ 2 thumb_NN1 is_VBZ to_TO **use**_VVI "_" 1_MC1 ton_NNU1 for_IF every_AT1 500_ 3 It_PPH1 is_VBZ important_JJ to_TO **use**_VVI the_AT correct_JJ procedure_NN1 for_

The top five verbs for the past participle form are *required*, followed by *based*, *used*, *released* and *shown*. The verb *required* is often used to explain the need for something when executing certain tasks as in sentences 3 and 4 in Table 9. It was also used to indicate a necessity to follow a particular rule as in examples 1 and 2. The verb *required* is ranked at number 98 in the HKEC's top 200 word list which shows the importance of this verb in authentic engineering writing. As for the verb *based* which commonly collocates with the preposition *on* as shown in Table 10, it was used mainly to illustrate that certain objects or processes are the basis for running other processes or doing certain actions as in 3 and 4. It was also used to explain how or why something comes to be as in 1 and 2. In the HKEC, *based* was not listed in the top 200 but figured prominently with 5000 occurrences and therefore will be considered as a verb with high relevance in professional engineering writing. The verb *released* is ranked fourth and was mainly used in the context of indicating that relevant machines and tools have undergone and passed certain procedures, and thus allowed to operate as before as illustrated in sentence 2 and 3 of Table 11. Finally, for the word *shown*, ranked fifth, it was commonly used with reference to a type of graphic as seen in sentences 1 and 2 in Table 12. *Released* and *shown*, however, are not listed in the top 200 list in the HKEC. In the academic domain, all the verbs except *released* are commonly used in academic writing and are listed as part of the AKL.

Table-9. Collocation lines for *required.*

1 To_TO supply_VVI electricity_NN1 as_CSA **required**_VVN by_II distribution_NN1
2 witching_JJ competency_NN1 certificate_NN1 as_CSA **required**_VVN under_II the_AT
3 1 (_(CAD_NN1)_) ._. First_MD Aid_NN1 is_VBZ **required**_VVN in_BCL21 order_BCL22
4 1 TAR_NN1 is_VBZ no_RR21 longer_RR22 **required**_VVN to_TO run_VVI ._. Bintulu_NN1

Table-10. Collocation lines for *based*.

1 defined_VVN into_II several_DA2 areas_NN2 **based**_VVN on_II transmission_NN1
2 of_IO EMPS_NP2 model_NN1 are_VBR **based**_VVN on_II the_AT historical_JJ inflow_
3 Optimization_JJ ofhydro_NN1 operation_NN1 **based**_VVN on_II the_AT historical_JJ inflow_ Z
4 Simulation_NN1 is_VBZ **based**_VVN on_II economic_JJ dispatch_NN1 ,_, which nected_JJ regions_NN2

Table-11. Collocation lines for *released*.

1 water_NN1 should_VM not_XX be_VBI **released**_VVN for_IF production_NN1 Temporary_JJ c
2 PASSED_VVD ._. -_- TOOL_NN1 **RELEASED**_VVN ._. Action_NN1 [_(Night_NNT1 Shift_
3 result_NN1 -_- Passed_VVD Tool_NN1 fully_RR **released**_VVN for_IF production_NN1

Table-12. Collocation lines for *shown*.

1 _IF Q1_FO 2018_MC is_VBZ as_CSA **shown**_VVN in_II the_AT table_NN1 below_
2 preceding_JJ transition_NN1 bath_NN1 as_CSA **shown**_VVN in_II Figure_NN1 1_MC1 &;
3 load_NN1 calculation_NN1 and_CC is_VBZ shown_VVN below_RL ._. 8.1_MC Outdoor_JJ

For the infinitive form, the four most used verbs are *to ensure*, *to include*, *to check* and *to provide*, followed by *to use* which is ranked fifth in frequency. Based on the collocation results as shown in Table 13, these words were used to indicate task purpose and in certain circumstances to specify 'precautionary' measures normally taken by engineers when executing tasks. Out of the four verbs, only *provide* is listed in the top 200 of the HKEC word list. Since the three other words did not appear in the top 200 word-list, a frequency check was done through the HKEC search page. *Ensure* and *include* have a frequency of more than 4000 respectively and can be considered as frequent since words in HKEC that are ranked 177 to 200 also have a range between 4000 to 5000. C*heck* can be considered less frequent since it only appeared in the writings approximately 2000 times. Additionally, all these verbs are listed as academic verbs in the AKL except for *check*.

Table-13. Collocation lines for *ensure*, *include*, *check* and *provide*.

Ensure
1 _JJ operational_JJ order_NN1 2_MC)_) To_TO **ensure**_VVI minimum_JJ interruption_NN1 of_IO 2 _IO power_NN1 generation_NN1 3_MC)_) To_TO **ensure**_VVI sufficient_JJ generating_JJ 3 the_AT genset_NN1 fault_NN1 to_TO **ensure**_VVI problems_NN2 will_VM not_XX be 4 on_II the_AT safety_NN1 To_TO **ensure**_VVI that_CST ISO14001_FO to_TO
Include
1 plant_NN1 ._. Each_DD1 subsystem_NN1 may_VM **include**_VVI hydropower_NN1 ,_, thermal_JJ 2 _NN1 ._. MRCo#01_FO MRCo#01_FO 1_MC1 ._. To_TO **include**_VVI annual_JJ exhaust_NN1 3 _NN1 on_II the_AT 1_MC1 ._. To_TO **include**_VVI external_JJ gauge_NN1 as_CSA extra_ 4 action(s)_NN2 TRCd#02_FO 1_MC1 ._. To_TO **include**_VVI external_JJ gauge_NN1 as_CSA
Check
1 test_NN1 is_VBZ intended_VVN to_TO **check**_VVI whether_CSW the_AT system_NN1 is_ 2 /p_ZZ1 2030SK_FO Barriers_NN2 (_(to_TO **check**_VVI the_AT availability_NN1)_) ii_MC)_) 3 2030SK_FO Analogue_JJ Barriers_NN2 (_(to_TO **check**_VVI the_AT availability_NN1)_) ._. 4 _FO MP-AI0-H-02-R_NP1 (_(to_TO **check**_VVI the_AT availability_NN1)_) iii_MC)_)
Provide
1 terminals_NN2 and_CC located_VVD to_TO **provide**_VVI proper_JJ room_NN1 air_NN1 distribution 2 this_DD1 document_NN1 is_VBZ to_TO **provide**_VVI the_AT E11_FO Mechanical_JJ Seal_ 3 records_NN2 ._. -Ability_JJ to_TO **provide**_VVI weekly_JJ hydro_NN1 generation_NN1 ,_,

For the '-ing' participle verb form, *using*, *causing*, *running*, *shaking* and *following* are in the top five. While some verbs are used in the present continuous form as in sentences 2, 3 and 4 for *running* in Table 14, for others, the root

verbs, are conjugated with '-ing' to form a gerund instead as shown in sentence 1 '*Running* the genset…' in the same table. Gerunds function as nouns and can in certain circumstances serve as a subject. The verb *causing* in particular was used mostly in a clausal manner to explain the effect or results of other simultaneous actions indicative of the explanatory nature of engineering texts as seen in Table 14, while *running* explains whether something, usually equipment, is working. Table 15 shows that *shaking* is a specific verb used to indicate the condition of machines or tools that go up and down or side to side rapidly and continuously. Finally, *following* as shown in the collocation lines in Table 16 served mostly as a gerund to explain something is done with reference to something else. Out of the five commonly occurring verbs, however, only *using* and *following* figured prominently in the HKEC. As for the AKL, only the verb lemmas *use* and *cause* are included.

Table-14. Collocation lines for *causing* and *running*.

Causing
1 ransformer_NN1 1_MC1 and_CC 2_MC tripped_VVD ,_, **causing**_VVG loss_NN1 of_IO 2 transformer_NN1 1_MC1 and_CC 2_MC tripped_VVD **causing**_VVG supply_NN1 3 chemical_NN1 present_NN1 on_II cassette_NN1 &; **causing**_VVG damage_NN1 on_II 4 dripped_VVD on_II cassette_NN1 intermittently_RR **causing**_VVG cassette_NN1 burnt_VVN
Running
1 operation_NN1 cost_NN1 by_II i_ZZ1)_) **Running**_VVG the_AT genset_NN1 in_II most_ 2 all_DB thermal_JJ units_NN2 are_VBR **running**_VVG at_II almost_RR maximum_JJ capacity_ 3 CC will_VM not_XX be_VBI **running**_VVG at_RR21 all_RR22 ._. 2012_MC Observat 4 E11K-A_NP1 are_VBR not_XX **running**_VVG ._. E11Q-A_NP1 ,_, E11K-A_

Table-15. Collocation lines for *shaking*.

Shaking
1 BUT_CCB STILL_RR A_RR21 BIT_RR22 **SHAKING**_VVG AFTER_II SPIN_NN1 1200_MC &; 2 TO_II CARD_NN1 CAGE_NN1 -_- STILL_RR **SHAKING**_VVG AFTER_II SPIN_NN1 MOTOR_NN1 COMMAND_ 3 - FURTHER_JJR VERIFICATION_NN1 DISK_NN1 SPIN_NN1 **SHAKING**_VVG ISSUE_NN1

Table-16. Collocation lines for *following*.

Following
1 the_AT renovation_NN1 project_NN1 by_II **following**_VVG the_AT end-user_NN1 functional_JJ 2 below_II weather_NN1 conditions_NN2 as_CSA **following**_VVG previous_JJ project_NN1 and_CC afte 3 to_TO express_VVI satisfaction_NN1 ._. **Following**_VVG above_II guide_NN1 ,_, for_IF this_ 4 processed_VVD both_DB2 Lots_NN2 by_II **following**_VVG the_AT recipe_NN1 ._. 4_MC Alignme

Table-17. Collocation lines for *found*, *closed*, *failed* and *passed*.

Found
1 _RA accessories_NN2 ._. Conclusion_NN1 1_MC1)_) **Found**_VVD only_RR 9_MC (_(nine_MC 2 _TO confirm_VVI this_DD1 issue_NN1 ._. 2_MC)_) **Found**_VVD that_CST SSB_NP1 did_VDD 3 process_NN1 loops_NN2 ._. No_AT conclusion_NN1 **found**_VVD ._. MFG_NP1 triggered_VVD 4 EDX_VV0 on_II burnt_JJ mark_NN1 **found**_VVD sulfate_NN1 ,_, suspect_VV0 from_II sul
Failed
1 the_AT two_MC tests_NN2 above_RL **failed**_VVD ,_, please_RR fine-tune_JJ the_AT 2 per_II below_RL :_: Equipment_NN1 Accessing_NN1 **Failed**_VVD ;_; Software_NN1 Error_NN1 3 same_DA error_NN1 occurred_VVD and_CC **failed**_VVD to_TO backup_VVI software_NN1 ._. 4 Wafer_NN1 Guide_NN1 Alignment_NN1 drifted_VVD ,_, **failed**_VVD transfer_NN1 &;
Closed
1 30_MC Nov_NPM1 Open_VV0 15_MC Oct_NPM1 **Closed**_VVD Fan_VV0 Out_RP Action_NN1 2 date_NN1 31_MC Jan_NPM1 2018_MC Status_NN1 **Closed**_VVD 30_MC Jun_NPM1 2018_MC 3 _NPM1 2016_MC 22_MC May_NPM1 2016_MC Status_NN1 **Closed**_VVD Closed_JJ D5_FO
Passed
1 Etch_VV0 Rate_NN1 -_- **Passed**_VVD c_ZZ1 ._. Metallic_JJ Check_NN1 2 run_NN1 P/Chk_NN1 result_NN1 -_- **Passed**_VVD Tool_NN1 fully_RR released_VVN for_ 3 QDR_NP1 Bath_NP1 pinch_NN1 test_NN1 **passed**_VVD ._. Methods_NN2 Alignment_NN1 ROB1-H3P

As for the past tense form, *found* had the highest occurrence, followed by *closed*, *failed*, *passed* and *forecasted*. *Found* and *failed* were mainly used to indicate a problem or issue which occurred during task execution, while *closed* and *passed* are specific verbs used mainly in the pass down instructions to indicate that a case, procedure or problem have been solved. Collocation lines for these verbs are shown in Table 17. As for the verb *forecasted*, it was commonly used for reviewing calculations of certain units relevant to engineering as shown in Table 18. All five verbs had low occurrences in the HKEC word list with *forecasted* ranked lowest amongst the five appearing only 10 times in the corpus. Of the five verbs, however, only the verb lemma *fail* is listed as an academic verb in the AKL.

Table-18. Collocation lines for *forecasted*.

Forecasted
1 higher_RRR than_CSN the_AT energy_NN1 **forecasted**_VVD in_II the_AT last_MD AGGP_
2 12.6%_FO higher_RRR than_CSN last_MD **forecasted**_VVD because_CS all_DB available_JJ unit
3 which_DDQ saw_VVD a_AT1 lower_JJR **forecasted**_VVD SPC_NP1 energy_NN1

Finally, for the least occurring verb form, which is the singular simple present tense, five verbs that were found to be most common are *shows*, *increases*, *needs*, *moves*, and *depends*. *Shows* which had a frequency of 14 were typically used to relate the discourse to a visual such as in sentences 1 and 4 in Table 19. It was also used in relation to or to explain numbers and figures as in sentences 2 and 3. Similarly, *increases* have a numeric function as shown in Table 20. Table 21 shows that the verb *needs* refer to the action of requiring something in task execution. Table 22 shows how the verb *moves* was used to indicate change or progress such as in sentences 1 and 2, as well as physical movement such as in sentences 3 and 4. Finally, for *depends*, which is characteristically followed by the preposition *on* was used to illustrate reliance of a condition or a process on something as illustrated in Table 23. Despite seemingly being important in the writings of engineers in this particular study for their explanatory functions, the five lexical verbs were not listed in the top 200 in the HKEC list, and were found to have low frequencies. In the academic domain, however, *show* and *increase* have been found to be prevalent.

Table-19. Collocation lines for *shows*.

1 _CC 2013_MC The_AT graph_NN1 below_RL **shows**_VVZ the_AT generation_NN1 in_II
2 1 for_IF internal_JJ heat_NN1 gain_NN1 **shows**_VVZ that_CST ,_, when_CS thinking_VVG about
3 _AT revised_JJ energy_NN1 in_II 2018_MC **shows**_VVZ an_AT1 increase_NN1 of_IO 4.21%_FO
4 1 Demand_VV0 The_AT table_NN1 below_RL **shows**_VVZ the_AT comparison_NN1 between_II

Table-20. Collocation lines for *increases*.

1 throughout_II the_AT year_NNT1 ,_, generation_NN1 **increases**_VVZ extensively_RR by_II
2 increases_NN2 ,_, the_AT generation_NN1 also_RR **increases**_VVZ by_II 40%_NNU over_RG
3 1 dominated_VVN as_CSA Bakun_NP1 plant_NN1 **increases**_VVZ its_APPGE capacity_NN1
4 _CC 2012_MC while_CS Murum_NP1 plant_NN1 **increases**_VVZ its_APPGE capacity_NN1

Table-21. Collocation lines for *needs*.

1 is_VBZ a_AT1 challenge_NN1 that_CST **needs**_VVZ to_TO be_VBI tackled_VVN with_
2 1 of_IO each_DD1 thermal_JJ unit_NN1 **needs**_VVZ to_TO be_VBI incorporated_VVN in_
3 how_RGQ much_DA1 the_AT air_NN1 **needs**_VVZ to_TO be_VBI cooled_VVN to_
4 22 ,_, the_AT main_JJ equipment_NN1 that_CST **needs**_VVZ to_TO be_VBI bypassed_VVN

Tabl-22. Collocation lines for *moves*.

1 mentioning_VVG that_CST the_AT System_NN1 **moves**_VVZ towards_II being_VBG hydro_NN1
2 as_II the_AT S_NP1 System_NN1 **moves**_VVZ from_II being_VBG thermal_JJ dominated_
3 Machine_VV0 Mechanism_NN1 Robot_NN1 1_MC1 **moves**_VVZ from_II INCTC_NP1 to_II
4 during_II transferring_VVG event_NN1 ._. ROB1_FO **moves**_VVZ to_TO CARO1/CHCL_VVI

Table-23. Collocation lines for *depends*.

1 the_AT wet-bulb_JJ thermometer_NN1 **depends**_VVZ on_II the_AT humidity_NN1 of_
2 loss_NN1 through_II a_AT1 building_NN1 **depends**_VVZ on_II :_: a_AT1 ._. The_AT
3 "_" Optional_JJ "_" means_NN that_CST review_NN1 **depends**_VVZ on_II scope_NN1 ._.

For this study, lexical verbs that are highly relevant for the engineering field refer to verbs with high frequency within the corpus and within the HKEC list. Of all the 30 lexical verbs, only eleven verbs can be considered as highly relevant for engineering. They are *use*, *proceed*, *required*, *based*, *used*, *to ensure*, *to include*, *to provide*, *to use*, *following* and *using*. Table 24 shows the lexical verbs that are highly relevant to engineering as well as those that show an overlap with the academic vocabulary in the AKL. Based on Cowan (1974) and Nation (2001) categorisations, none of the eleven highly relevant verbs can be considered as technical, sub-technical or semi-technical. These verbs, therefore, are non-technical verbs as they were used in the general sense without specialised meaning when used in the context of the present study.

Table-24. Distribution of top 5 lexical verbs in each form between the HKEC, AKL and relevance for engineering.

No	Verb	HKEC	AKL	High Relevance	No	Verbs	HKEC	AKL	High Relevance
1	refer		√		16	using	√	√	√
2	check				17	causing		√	
3	use	√	√	√	18	running			
4	proceed	√		√	19	shaking			
5	make				20	following	√	√	√
6	required	√	√	√	21	found			
7	based	√	√	√	22	closed			
8	used	√	√	√	23	failed		√	
9	released				24	passed			
10	shown		√		25	forecasted			
11	to ensure	√	√	√	26	shows		√	
12	to include	√	√	√	27	follows		√	
13	to check				28	increases		√	
14	to provide	√	√	√	29	needs			
15	to use	√	√	√	30	moves			

Evidently, ten out of eleven English lexical verbs also figured prominently in the AKL causing an overlap between the two. This is an important finding because this shows that academic verbs that are considered crucial for tertiary learning are in line with those verbs that are commonly used in authentic workplace writing particularly in the context of second language writing. At least, in the case of engineering writing as investigated in this small-scale study. It is important to note, however, the results and findings of the study are limited to a small number of texts from the industry and may not be representative of writing in the field.

4. CONCLUSION

In the present study, the most common form of lexical verb found in professional engineering writing is the base form while the third person singular present verb form was the least occurring form. The prevalence of the base form was reflective of the extensive use of imperatives for 'pass down' instructions while the low usage of the singular form may correlate with the infrequent use of active forms. In many studies of workplace engineering texts, it is not uncommon for passivity as signified by the frequent use of the past participle to be the centre of the discussion. As revealed by this small corpus, although the past participle was not at the top of the list, it was ranked second in occurrence. Lexical verbs that figured prominently in the texts include refer, check, shown, required, based and ensure among others. One lexical verb worthy of mention is *use* in four of its forms namely the base form, the infinitive, the past tense and the continuous '-ing' tense. More importantly, *use*, *used* and *using* are listed in the top 200 in the HKEC word list which shows their relevance in workplace writing. Of all the 30 lexical verbs in the

top 5 for each verb form, only 11 can be considered as highly relevant for engineering. None of these verbs, however, fit the characteristics of technical, semi-technical or sub-technical vocabulary. In fact, they are non-technical verbs that were used in a general context without field-specific or specialised meaning but were highly relevant for engineering writing. Ironically, almost all of these verbs also figured prominently in the AKL list as characteristic of academic vocabulary. What this finding suggests is that academic verbs that are considered crucial for tertiary learning are consistent with those verbs that are used in authentic workplace writing especially in the context of second language writing. It is hoped that this study can aid students, teachers and novice practitioners in their choice of vocabulary particularly verbs for the written discourse of academic or professional engineering.

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