

Predicting the Performance and Success of Construction Management Graduate Students using GRE Scores

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Some construction management (CM) programs in the United States of America (USA) use Graduate Record Examination (GRE) scores as part of their graduate admission requirements because they tend to believe that the exam can predict academic performance and success of students. A study was conducted in the southeastern and central part of the USA with the purpose of assessing the predictive ability of admission GRE scores on the success of graduate students in the CM programs. The hypothesis was that students who scored high in GRE were more likely to succeed by graduating within two years and not drop out. The independent variables were GRE verbal, GRE quantitative and total GRE scores while the dependent variable was the success (or not), a binary measure. SAS v9.4 was used to analyze the data obtained from two CM graduate schools in the USA. The results showed non-significant predictive abilities of the variables tested. Thus, the hypothesis of higher GRE scores being associated with higher success rates was not supported. It was recommended that admission committees should re-assess requiring GRE scores.

Key Words: Construction Management, Graduate Students, GRE, Performance and Success, Predict

Introduction

Admission committees of construction management (CM) programs in the United States of America (USA) face difficulty each year in selecting qualified students who they believe will eventually succeed in their graduate educational pursuit (Wao, Ries, Flood, Lavy & Ozbek, 2015b). Attracting and enrolling diverse student body is always challenging to them (Cole, 1998). They strive to follow admission criteria so that the students, upon graduating, would be reflective and representative of the construction industry work force in terms of diversity and high performing individuals. In order to achieve this, they are keen to select those students with high cognitive abilities who they believe would succeed in graduate education (Kuncell, Wee, Serafin & Heztel, 2010).

Making good admission decisions require different sources of information about the applicants. These may include letters of recommendations, previous construction industry work experience, interviews with the graduate school personnel, personal statements of purpose, Undergraduate Grade Point Average (UGPA) and Graduate Record Examination (GRE) scores (Wao et al., 2015b; Reisig & Dejong, 2005).

A close analysis of graduate admission criteria of some of the CM programs in the USA indicate that the GRE is an important requirement that admission committees require potential applicants to take and achieve scores that meet the requirements for admission. This is because the CM program admission decision-makers tend to believe that GRE scores could be good indicators of success in graduate education. A body of research indicated that student attrition and provision of remedial learning opportunities to those students who are struggling academically tend to be costly to universities based on finance, time, and human resources (Ultzman, Riddle & Jewell, 2007). Thus, the CM admission committees must strive to identify and select qualified students who would most likely not face difficulties when pursuing their graduate education.

An array of research has shown that GRE is not a valid predictor of success in CM graduate studies and that it is used as a gatekeeper that limits unbiased access across groups to higher education (Bleske-Rechek & Browne, 2014; Toyama, 1999). In light of this, some universities such as Arizona State University have CM programs that have stopped using GRE scores to admit their graduate students while others have resorted to using customized graduate

admission examinations that reflect specific program requirements (Wao et al., 2015b; Mupinga & Mupinga, 2005). On the contrary, some believe the GRE score is reliable, valid and predictive of graduate performance and should be used to inform admission decisions (Norcross, Hynch & Terranova, 1996). Thus, schools like University of Florida, Colorado State University and Auburn University still use GRE scores to admit CM graduate students.

This research investigated the GRE score as a predictor of performance and success of students in two major CM graduate programs in the southeastern and central region of the USA. GRE score was the predictor variable used to predict the performance and success of students. Performance and success was determined when students were able to graduate within the two-year duration given for most CM masters programs. The research utilized quantitative statistical analysis to examine the level of performance and success using GRE scores as the predictor since admission committees tended to use it with other requirements when admitting graduate students.

Literature Review

Defining GRE scores for graduate educational success

GRE is a set of standardized tests designed to determine the scholastic potential of graduate students in the USA. The GRE general test measures the verbal reasoning (GREV), quantitative reasoning (GREQ), critical thinking and analytical writing skills (GREA) required for success in graduate studies (Educational Testing Services, 2015). GREV measures the ability to analyze and evaluate written materials, synthesize the information obtained from it, analyze relationships among different parts of a sentence, and recognize relationships among words and concepts. GREQ tests problem solving ability focusing on basic concepts of arithmetic, algebra, geometry, and data analysis. GREA measures critical thinking and analytical writing skills, specifically the ability to articulate and support complex ideas clearly and effectively (Wang, 2013).

Ideally, the GRE functions as an intelligence test. Research has shown GRE to function as a test of general cognitive abilities because verbal and quantitative reasoning abilities represent speed and efficiency with which individuals attain both declarative and procedural knowledge in their intellectual pursuits (Kuncel et al., 2001). According to Kuncel et al. (2001), graduate education is an intellectual pursuit that demands both declarative and procedural knowledge. As such, student performance on the GRE is a strong predictor of graduate educational success. This graduate success has multiple ways of defining it, e.g., graduate GPA, first year GPA, comprehensive examination score, faculty rating, degree attainment, and time to degree (Kuncel et al., 2010). Some researchers relate the cognitive ability to job knowledge where performance is for declarative knowledge (realizing what to do when faced with a problem) and procedural knowledge (being able to finish a task) and motivation driving one to complete tasks (Wao et al., 2015a; Kuncel et al., 2001). Test takers solve complex and simple problems. This, Kuncel et al. (2001) argue would be applicable or translated to job knowledge. Thus, new graduates with high GRE scores would possess more job knowledge and skills and would perform better in graduate school compared to those with less knowledge.

Predictive ability of GRE scores on graduate educational success

Studies show that the predictive ability of GRE scores tend to improve when a particular test matches a specific discipline in such a way that the GRE verbal score is a modest predictor of success in descriptive disciplines while the GRE quantitative score is a better predictor in symbol-oriented disciplines (Wao et al., 2015b; Orlando, 2005). In as much as this could be true, there are mixed outcomes and inconsistencies in the predictive ability of GRE scores on graduate success. Some studies use first year GPAs, UGPAs and/or final GPAs while others use percentage of students who completed their academic programs to predict graduate success (Wao et al., 2015b; Orlando, 2005).

Many studies have reported correlations or indices of relationship in the predictive ability of GRE scores. The research outcomes show varied inconsistencies. Wang (2013) investigated the predictive ability of GRE scores on graduate performance of engineering discipline with graduate performance measured by GPA. The results showed that first year graduate GPA correlated with GREV at 0.17 and GREQ at 0.22 but the GRE scores actually had higher correlations with graduation GPA (GREV, $r = 0.21$; GREQ, $r = 0.26$). Klieger et al. (2014) investigated the predictive validity of GRE scores for graduate programs in 10 Florida public universities and found that the GREA scores correlated at 0.19 overall and 0.15 for business, management and marketing graduate programs. Young et al.

(2014) investigated the validity of revised GRE scores on graduate performance in business school using Hierarchical Linear Modeling (HLM). The results showed that both GREQ and GREV were statistically significant predictors of both first semester of Masters of Business Administration (MBA) GPA and cumulative MBA GPA. Overall, the results for the MBA program were GREQ v GPA ($r = 0.37$), GREV v GPA ($r = 0.24$), GREA v GPA ($r = 0.11$), and UGPA v GPA ($r = 0.19$). Wao et al. (2015b) investigated the predictive ability of GRE scores on CM students and found GPA vs GREQ to be 0.114 while GPA vs GREV to be 0.061. These studies have shown the GREQ scores to be a relatively better predictor of graduate success than the GREV and GREA scores.

Some studies have shown the opposite of this trend where GREV is a better predictor of graduate success. A meta-analysis study by Kuncel et al. (2001) found correlation of GPA vs GREV to be 0.23 and GPA vs GREQ to be 0.21 where they concluded that GREV is a valid predictor of graduate success. Stack and Kelley (2002) study in criminal justice discipline showed GREV to be better than GREQ in predicting GGPA (Standardized regression coefficients being 0.336 and 0.245 respectively). Shaurette and Rapp (2014) investigated the writing challenges experienced by 18 CM students during their theses or graduate writing assignments. They found the GREV and a principle of effective writing test correlating at 0.440 while the GREV correlated with short writing paper at 0.588. The strong correlation indices implied that GREV was a valid predictor of writing performance of CM graduate students.

Other studies have shown no predictive ability. Brown (2011) investigated whether established admission criteria at Grand Valley State University (GVSU) reliably predicted success within the nursing program and if so, whether one criterion was a better predictor of success. Success was measured by the ability to complete the academic program. Data of 256 graduate students were gathered where 159 of them completed the program. The results showed no significant difference between those who completed the program and those who did not. In addition, there was a significant relationship between UGPA and GGPA. UGPA for those who completed their degrees were higher than those who did not complete the program. Based on their findings, GRE scores did not predict academic success in the sample admitted to the graduate nursing program at GVSU. Results suggested that UGPA may predict academic success more than the GRE score in the nursing program (Brown, 2011). Similar research by Suhaydra et al. (2008) found no predictive ability of the GRE scores on the graduate academic success as measured by GPA.

This review of literature has shown varied and inconsistent predictive abilities of GRE scores on the success of students. Overall, the literature review has shown some deficiency in the use of GRE to predict academic performance and success of CM students especially their degree completion rates. This gap motivated conducting a predictive research in the CM discipline with special emphasis on their abilities to complete their degrees.

Research Methods

This research began by collecting data from two CM graduate educational programs. The data were then screened for any anomaly before statistical analysis comprising of descriptive and inferential analyses were conducted. Specifically, the descriptive statistics comprising of measures of central tendency (mean, mode, and median) and measures of dispersion (standard deviation, skewness, kurtosis, and box plot distribution) showed how the GRE scores and success rates (or ability to graduate) were distributed. Parametric or inferential statistics comprising of *t*-test, correlation, and regression analyses tested the research hypothesis. Specifically, pooled *t*-test investigated the mean difference between those who succeeded and those who did not (Wao et al., 2015a). Correlation analysis using modified Pearson correlation coefficient guide determined the level of relationship among variables (Wao et al., 2015b). Logistic regression determined the likelihood by which the GRE scores predicted graduate success. Goodness of fit statistics assessed the fit logit model against the outcomes (Peng et al., 2002).

Aim, Objectives and Hypothesis of the Study

The aim of the study was to investigate the predictive ability of GRE scores on graduate educational performance and success of CM graduate students. The objective was to determine the correlations between GRE scores (GREV, GREQ, GREA and GRETOTAL) for those who succeeded in their graduate studies and those who did not succeed. The hypothesis was that CM students who scored higher in the GRE would be more likely to graduate within two years required for the master's program and would be considered successful in their CM educational pursuit.

Sample Size and Demographics

The original sample size was 390 students ($N = 390$) with their GRE and GPA scores. The data were sourced from two major CM graduate schools in the USA that had long history and tradition of excellence in CM education. After data screening to remove errors and anomalies in the score entries, the new sample size was 259. This convenient sample was considered representative of the CM schools in the USA. It comprised of students who had successfully completed their graduate education ($N = 193$) and those who had not ($N = 66$). Additionally, it was from those who were admitted from Spring 2007 until Fall 2013 semester. Specifically, the data were for those who graduated and those who did not graduate by spring 2015. A year of student data implied data for those graduating in the spring, summer and fall semesters of a particular academic year.

The sample comprised of both successful (those who completed the CM program in two years) and unsuccessful (those who had not completed or did not complete in two years). They were from diverse socio-cultural, economic, and political backgrounds. All had to take the GRE before being admitted into the program and would graduate only after completing the full CM graduate school requirements. The outcome of the study could be generalized to the masters CM programs in the USA. That is, the population of interest is CM masters students in the USA.

Description of Data, Research Variables and Data Analysis

The data comprised of the GRE scores and success (or not) scores. The GRE scores were continuous scores while success (no success) scores were binary scores (0 or 1). Zero (0) implied that the student was not successful in the program while 1 implied success by completing and graduating within two years.

Since the new GRE came into use after August 1, 2011, all the GRE data were translated into the new GRE format using the conversion table provided by ETS for the year 2015-16. This new GRE score scale ranges from 130-170 for GREV and GREQ sections respectively, while GREA ranged from 0-6. For this data, total GRE scores ranged from 268 to 327 while GREA ranged from 0.5 to 5.5. The universities required students to score about 300 or above in the GRE in order to secure admission and to maintain a 3.00 GPA in order to graduate in good academic standing.

The independent variables were GRE verbal (GREV) score, GRE quantitative (GREQ) score, GRE analytical (GREA) score and total GRE score (GRETOTAL). The dependent variable was the success (no success) coded as 1 or 0. SAS v9.4 served as the statistical data analysis tool.

Results

Descriptive statistics

The descriptive statistics calculated and presented comprised of measures of central tendency (mean, mode and median values) and measures of dispersion (standard deviation, skewness, kurtosis, distribution plot, and minimum and maximum values) for the respective variables. The results were for all students and for those who were successful and not successful separately. Table 1 presented the results for all the students.

Table 1. Descriptive statistics of GRE scores

| Variable | N | Mean | Median | Mode | Std | Skew | Kurt | Min | Max | Distribution plot |
|----------|-----|--------|--------|------|------|-------|-------|------|-----|--|
| GREV | 259 | 150.47 | 151 | 151 | 6.14 | -0.11 | 0.23 | 130 | 166 | Normal distribution with 2 upper and lower scores |
| GREQ | 259 | 152.73 | 152 | 151 | 5.60 | 0.47 | -0.06 | 138 | 169 | Normal distribution with 1 upper and 1 lower outlier |
| GREA | 259 | 3.59 | 3.5 | 4 | 0.79 | -0.68 | 2.29 | 0.50 | 5.5 | Normal distribution with 3 lower outliers |
| GRETOTAL | 259 | 303.2 | 302 | 299 | 8.58 | 0.13 | 0.95 | 268 | 327 | Normal distribution with 1 lower outlier |

In Table 1, the GREV, GREQ, GRE and total GRE scores for all the students were relatively normally distributed even though there were some extreme scores or outliers on the upper and lower sides of the distribution scale.

Table 2 shows the results from the analysis of the differences in performance in GRE for those who succeeded and those who did not succeed in their CM graduate education. On average, the scores were normally distributed.

Table 2. Descriptive statistics by 'success' and 'no success' in CM graduate education

| Variable | GREV | | GREQ | | GRE | | GRETOTAL | |
|------------------------|------------|---------|------------|-------------------|-------------------|---------|------------|---------|
| | No-Success | Success | No-Success | Success | No-Success | Success | No-Success | Success |
| N | 66 | 193 | 66 | 193 | 66 | 193 | 66 | 193 |
| Mean | 150.35 | 150.51 | 152.1 | 152.94 | 3.65 | 3.56 | 302.44 | 303.46 |
| Median | 150 | 151 | 151 | 152 | 3.5 | 3.5 | 302 | 302 |
| Mode | 149 | 147 | 148 | 151 | 4 | 4 | 299 | 298 |
| Std | 6.74 | 5.94 | 6.59 | 5.21 | 0.72 | 0.81 | 9.63 | 8.21 |
| Min | 130 | 133 | 138 | 142 | 2 | 0.5 | 268 | 282 |
| Max | 164 | 166 | 166 | 169 | 5.5 | 5.5 | 327 | 325 |
| Distribution of scores | Normal | Normal | Normal | Positively skewed | Positively Skewed | Normal | Normal | Normal |

Pooled *t*-test statistics tested the mean differences in scores between those who were successful and those who did not succeed in their CM graduate educational pursuit. The pooled *t*-test assumed equality of variance and the results were as follows:

- GREV: [$t(257) = -.19, p = .8514$].
- GREQ: [$t(257) = -1.07, p = .286$].
- GRE: [$t(257) = .80, p = .426$].
- GRETOTAL: [$t(257) = -.83, p = .41$].

The interpretation of *p*-value is to reject the null hypothesis when *p*-value is less than 0.05 suggesting a statistically significant difference in the result or fail to reject the null hypothesis if *p*-value is greater than 0.05 suggesting insufficient information to reject the null hypothesis. Thus, it is clear from the non-statistical significant *t*-test results that the performance in GRE does not differ between those who were successful and those who were not successful in their CM graduate educational pursuit. Other factors could attribute to the ability to succeed.

Correlation between the score variables

Correlation analysis investigated the strength of the relationship among GREV, GREQ, GRE and GRETOTAL for those students who succeeded and those who did not succeed in CM graduate education. Using the modified Pearson correlation coefficients guide from Wao et al. (2015b), the interpretation of correlation indices are; +/- 0.7 and higher = very strong positive/negative relationship, +/- 0.4 to 0.69 = strong positive/negative relationship, +/- 0.3 to 0.39 = moderate positive/negative relationship, +/- 0.2 to 0.29 = weak positive/negative relationship, +/- 0.1 to 0.19 = very weak relationship and +/- 0.01 to 0.09 = negligible relationship. This implies that the results ranged from moderate positive to negligible relationships. Figure 1 shows the correlation indices between the variables assessed.

The graphical plot in Figure 1 shows the relationship between GREV and GRETOTAL recording a relatively higher correlation index on average for those who succeeded in their college career than the rest. This was followed by those who did not succeed and then GREQ v GRETOTAL for those who did not succeed in that order.

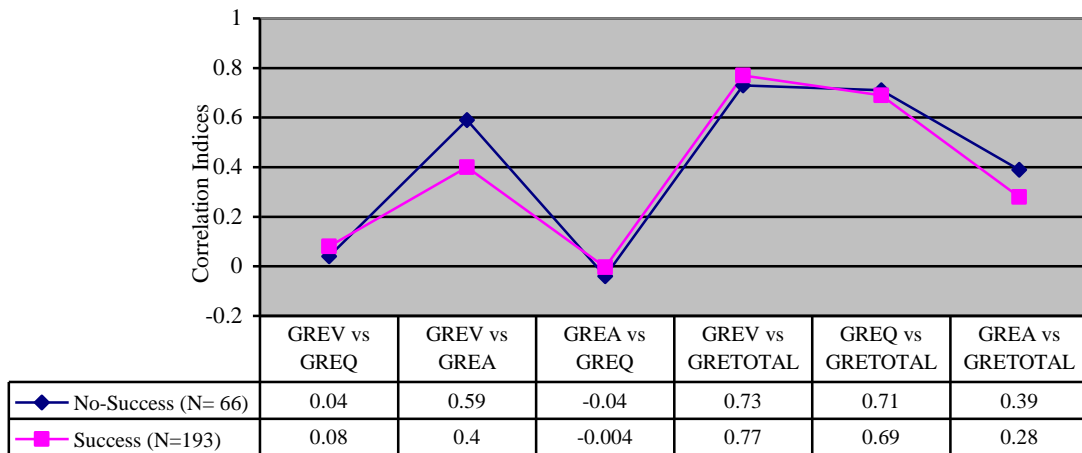


Figure 1. Correlation coefficients of GRE verbal (GREV), GRE quantitative (GREQ), and GRE Total (GRETOTAL) for students who succeeded and those who did not succeed in their graduate education.

Logistic regression of the score variables

Logistic regression analysis evaluated how the different variables predicted the ability to succeed (or not) in the CM program. Specifically, the logistic regression coefficients give the change in the log-odds of the outcome (in this case, ability to succeed) for a unit increase in the GREV, GREQ, GREA, and GRETOTAL. In the analysis, SAS modelled success variable using binary logit model. Consequently, the probability of success = 1 was modelled.

The results showed the likelihood ratio test Chi-Square value of 2.06 with a *p-value* = 0.56 implying that the model fitted well. The non-statistical significant test suggested that the model fitted and so it was okay to proceed with the logistic regression analysis. This is the goodness of fit statistic interpreted from Peng et al. (2002). The maximum likelihood estimates in Table 3 show the coefficients (labelled as estimates), the Chi-Square statistics, and related *p-values*. Note that the coefficients of GREV, GREQ, GREA and GRETOTAL are not statistically significant at $p = 0.05$ implying that they do not contribute in determining whether a student would succeed or not in the CM program.

Table 3. Logistic regression analysis of score variables (N = 259)

| Analysis of Maximum Likelihood Estimates | | | | | |
|--|----|----------|----------------|-----------------|------------|
| Parameter | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
| Intercept | 1 | -4.3645 | 5.2416 | 0.6933 | 0.4050 |
| GREV | 1 | 0.0140 | 0.0266 | 0.2777 | 0.5982 |
| GREQ | 1 | 0.0265 | 0.0263 | 1.0129 | 0.3142 |
| GREA | 1 | -0.1956 | 0.2110 | 0.8601 | 0.3537 |
| GRETOTAL | 1 | 0.0139 | 0.0168 | 0.6903 | 0.4061 |

In Table 3, the estimates suggest that for every unit change in the GREV score, the log odds of success (versus no success) increases by 0.014. This increases by 0.0265 for GREQ, 0.0139 for GRETOTAL and -0.1956 for GREA.

Table 4 shows the indices given as odds ratio. Ideally, the Wald and the odds ratio are two ways of saying the same thing. The value of the point estimate imply that for one unit increase in the GREV and GRETOTAL, the odds of being successful in CM graduate school (versus not being successful) increases by a factor of 1.014. For GREQ, the odds of being successful increases by 1.027 and 0.822 for one unit increase in GREA. These small values suggest relatively little improvements in the probabilities of success in the CM programs.

Table 4. Odds ratio estimates for the score variables (N = 259)

| Effect | Point Estimate | 95% Wald Confidence Limits | |
|----------|----------------|----------------------------|-------|
| GREV | 1.014 | 0.963 | 1.068 |
| GREQ | 1.027 | 0.975 | 1.081 |
| GREA | 0.822 | 0.544 | 1.243 |
| GRETOTAL | 1.014 | 0.981 | 1.048 |

Discussion and Conclusion

There are varied inconsistencies in the ability of GRE to predict performance and success of graduate students. In spite of the inconsistencies, some graduate educational programs in the USA still use GRE scores to admit students as they believe that the score could predict success in graduate school. This research investigated the predictive ability of the GRE score on the success of CM graduate students in the USA. The success was defined as the ability to graduate from CM programs within two years that is usually the standard duration to complete graduate education in most CM graduate programs. Different descriptive and inferential or parametric statistical results were reported.

The performance in GRE was relatively high as depicted by the relatively normal distributions of scores in GREV, GREQ, GREA and GRETOTAL for all the students and by distinguishing them by their ability to succeed or not in the CM programs. The non-statistically significant *t*-test results of GRE scores between those who succeeded versus those who did not succeed imply that performance did not differ by the ability to succeed or not. Other factors other than the test such as motivation, finance or family issues could contribute to the ability to succeed or not succeed in the program. Based on the results, it is logical to reject the hypothesis developed for this study and conclude that the ability to succeed in the CM graduate education does not depend on the GRE scores.

The correlation coefficients between the GREV, GREQ, GREA and GRETOTAL were relatively moderate. GREV correlated very strongly with GRETOTAL implying that those who scored higher in GREV were more likely to get higher GRETOTAL scores and subsequently get admission. However, securing entry does not guarantee success since the correlation values are not good enough to support eventual success. Thus, admission committees may not have enough reason to emphasize GREV in the quest for greater success rate in the CM graduate programs.

The logistic regression results showed some little odds of achieving success from the GRE variables investigated. However, none of the variables was statistically significant in predicting the chances of success. Thus, the outcomes of logistic regression analysis, correlation indices, and *t*-test showing non-statistical significance and little predictive ability are in line with the outcome of the study by Wao et al. (2015b) that found little predictive ability of GRE on the graduate success. In addition, it aligns with Brown (2011) that found no statistical difference between those students who completed the program and those who did not complete and were therefore not successful.

In conclusion, this research showed that the GRE score could not be a good predictor of academic success of CM graduate students. The correlation and logistic regression coefficients are not statistically significant to warrant any conclusion of reliable predictive ability of the GRE scores. It would be logical to conclude that other factors such as emotional stability, motivation, good forecast, age, gender, ethnicity or socio-economic status could influence the ability to succeed. Overall, the inability of the GRE score to predict performance and success of CM students may prompt the admission committees to re-evaluate their admission criteria for admitting CM students. They may need to re-assess their admission requirements or use of GRE scores to predict graduate educational performance and success. This research contributes to the predictive research in the area of performance and success of CM students in the USA. Its outcomes could provide useful information for CM graduate program admission committees.

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