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Are Construction Management Education Programs Producing Sufficient Numbers of Minority Graduates to Meet Demand?

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Abstract – The Bureau of Labor Statistics projects that the demand for qualified construction managers will grow eight percent between 2021 and 2031. It is anticipated that much of this demand will be generated by construction projects funded by the Investment and Jobs Act (IIJA). Although requirements may vary, publicly funded construction projects are often required to meet participation goals for Minority-owned Business Enterprises (MBEs). The increased demand for construction managers created by the IIJA will likely lead to increased demand for *minority* construction managers. Increased demand without sufficient supply leads to shortages.

Potential employers often use completion of a formal education program as a screening criterion to deem an entry level candidate as "qualified." Therefore, undergraduate construction education programs are likely to be called upon to produce qualified construction managers to meet the burgeoning demand. Further, there will likely also be a need for these programs to increase the percentages of minority graduates to provide sufficient numbers of MBE contractors to meet local, state, and federal targets.

This paper aims to determine whether existing four-year construction management higher education programs are producing sufficient numbers of minority graduates to support increasing construction manager demand. Graduation rate data collected from colleges and/or universities with four-year undergraduate degrees in construction management education in a specified geographic area will be used to investigate whether existing programs will be able to produce sufficient numbers of minority graduates to increase the number of qualified, entry level, minority construction managers available to meet growing demand. Regression analysis will be used to identify any trends that might exist in the number of students enrolling in and successfully completing construction education programs as well as trends that might exist among minority populations.

Introduction

Much of the discussion regarding the employment needs of the construction industry concerns the continuing shortage of skilled labor. One segment of the construction industry workforce that is not discussed as much on an individual basis is construction management. The employment need for construction managers is expected to grow by 7.6% between 2021 and 2031 [1]. The distinction between the employment outlook for construction workers and the employment outlook for construction managers is important when trying to ascertain whether a shortage of qualified construction managers exists in addition to the overall industry shortage. Much of the anticipated increase in the need for construction managers may be fueled by the Infrastructure and Investment in Jobs Act (IIJA). The IIJA will fund billions of dollars of construction projects and public sector construction programs include minority participation requirements.

However, although minority participation targets exist for federal contracts, there are no such targets specifically for the use of minority construction managers. Therefore, although employers in the construction industry now find themselves focusing on diversity, equity, and inclusion (DEI) efforts, it may be difficult to quantify the success of those efforts when it comes to recruiting and employing minority construction managers.

While the "demand" for minority construction managers may be difficult to quantify, the "supply" of minority construction managers may also be difficult to quantify. Entry level construction managers may have degrees in not only construction management, but also architecture, engineering, management, or a related field. Programs in any of these fields might contribute to the "supply" of minority construction managers. In fact, in many cases, construction is still considered to be a sub-discipline or specialty within civil engineering. Even when construction management is a standalone program, in many cases, the standalone program is still located within a college or school of engineering. The American Council for Construction Education (ACCE) has accredited 75 baccalaureate programs with 31 of those programs located within colleges or schools of engineering, engineering and technology, architecture and engineering, or architecture, engineering, and technology [2]. Further, some construction management programs are also accredited by the Accreditation Board for Engineering and Technology (ABET). ABET has accredited construction management programs at 33 institutions using its Applied Natural Science Accreditation Commission (ANSAC) criteria. ABET has also accredited construction engineering technology programs at 33 institutions using its Engineering Technology Accreditation Commission (ETAC) criteria and construction engineering programs at 27 institutions using its Engineering Accreditation Commission (EAC) criteria [3].

Clearly, construction management remains intertwined with engineering. This connection cannot be ignored or discounted when studying the "supply" of construction managers. The Bureau of Labor and Statistics (BLS) defines a construction manager as someone who "plan[s], coordinate[s], budget[s], and supervise[s] construction projects from start to finish" in the Occupational Outlook Handbook (OOH) [1]. The work of construction management (planning, coordinating, budgeting, and supervising) involves solving problems whether those problems are before the start of construction (planning and budgeting), during construction (coordinating and supervising), or after the completion of construction. While this work does involve quite a bit of "management," there is also quite a bit of "engineering" as well. Lucas and Dobrijevic define engineering as "the application of science and mathematics to solve problems [4]." A construction manager planning and scheduling a construction project might use equations and algorithms to determine activity sequences or to manage resources. In this way it seems that a construction manager is applying science and mathematics to solve *management* problems. Several schools including the University of Arkansas – Little Rock, The Citadel, Iowa State University, Marquette University, University of Nebraska – Lincoln, University of New Mexico, North Carolina State University, North Dakota State University, San Diego State University, and the University of Texas – El Paso continue to house their construction management programs within departments of civil engineering or civil, construction, and environmental engineering.

This paper aims to investigate whether four-year baccalaureate programs in construction management at higher education institutions are producing "sufficient" numbers of minority graduates to adequately participate in the employment growth of construction managers. Graduation rate data collected from colleges and/or universities with four-year undergraduate degrees in construction management (CIP 52.2001) in Louisiana will be used to investigate whether existing programs will be able to produce sufficient numbers of minority graduates to increase the number of qualified, entry level minority construction managers available to meet growing demand.

Background

Minority Representation in the Construction Industry

In the United States, the white race is still the majority race and whites dominate the construction industry. Members of all other races are racial minorities. In 2015, in the U.S., racial minorities accounted for only 19.0% of the workers in the construction industry and only 11.4% of construction managers [5]. Increasing the number of minority workers in the construction industry may be one way to help address the industry's labor shortage. According to Choi et al, the construction industry will need to attract untapped human resources such as racial minorities and women [6]. In fact, Manesh et. al, theorize that diversifying the construction workforce is an effective strategy to ensure the economic growth of the nation and will also help the industry to meet the increased demand for new workers [7]. The potential for additional minority representation in the construction industry remains great. In 2021, only 11% of construction workers were women, 6.3% were African American and 2.1% were Asian. Choi et. al. identified insufficient interest and poorly sustained participation in Architecture, Engineering and Construction (AEC) careers from underrepresented demographic groups as a critical issue. Compounding this issue is decades of isolating racial minority communities virtually ensuring that the people in these communities lack technical and job readiness skills [6]. Available labor continues to decline due to declining interest, aging population, and talent pressures from competing industries [8]. Diversity, equity and inclusion efforts in hiring may produce additional resources to meet the burgeoning employment demand [8]. However, it is not clear to what extent minority participation in the construction industry will increase due to these efforts. Therefore, it is reasonable to explore multiple strategies to generate the needed participation.

One strategy utilized by the federal, state, and local governments to increase minority participation in the construction industry is to set minority participation targets thus incentivizing the utilization of Minority-owned Business Enterprises (MBEs) to complete construction projects. There is often an offer of a competitive advantage to qualified MBEs or affiliates of qualified MBEs bidding on public sector projects. Although there does not appear to be any research regarding whether there is a direct correlation between MBE participation in construction projects and the demand for minority construction managers, design firms and contractors that are qualified as MBEs may have a need to hire construction managers and may target minorities for those openings.

Construction Management as a Profession

Construction Management as a profession has evolved from the need to effectively manage the business and financial components of construction projects. Historically, prior to the 1960s, construction project management activities were conducted by architects and engineers [9]. These architects and engineers utilized their professional expertise to complete the necessary project management activities while allowing construction laborers and tradesmen to focus on actual construction activities.

Today, while architects and engineers may still serve as construction managers, others choose to become full time construction managers. Construction managers may be employed by designers, contractors and even owners.

Construction managers are responsible for the planning, coordination, and supervision of construction projects. Important qualities for a successful Construction Manager include analytical skills, business skills, communication skills, decision-making skills, leadership skills and technical skills [1]. Entry level positions often require a bachelor's degree in construction management, business, engineering, or a related field. In some instances, a high school diploma and several years of experience may qualify for a position as a construction manager. However, it is more likely that someone with these limited qualifications would be a self-employed general contractor than to be hired as a construction manager at a larger firm [1]. However, some firms might recognize the value of years of field experience as an adequate trade-off for formal education. Yet, it would be difficult to predict how many such opportunities might exist.

U.S. News and World Reports list Construction Manager as number one on its list of Best Construction Jobs and number forty-four on its list of 100 Best Jobs [10]. The median salary for construction managers in 2021 was $98,890 with the top 25% earning $127,110 or greater and the top 10% earning more than $163,000. In addition, the satisfaction level of professionals working in the construction industry is higher than average [1]. These facts could make the field of Construction Management attractive to those who might still be unsure of their desired career.

"Demand" for Construction Managers

Demand can be defined as the amount of goods or services that consumers are willing to purchase at a given price. This definition implies that consumers are not only willing to purchase the goods and services but also have the means to purchase the goods and services. Supply, therefore, can be defined as the amount of goods and services available to be purchased. A shortage exists when demand exceeds supply. Therefore, exploration of whether there is a shortage of construction managers requires an understanding of both the demand for construction managers and the supply of construction managers. For the purposes of this study, employers in the construction industry are our consumers. Job openings are evidence of their willingness and ability to "purchase" construction managers.

In 2021, 284,750 people were employed as construction managers. It is expected that there will be an average of 41,500 openings each year for new construction managers [1]. Attrition of workers who choose to leave the workforce or transfer to different occupations and/or industries accounts for many of these openings [1]. This can be considered the "demand" for construction managers. Since entry level construction management positions require at least a bachelor's degree in construction management or a related field, most "supply" is generated by construction management graduates. It is recognized that not all construction management job opportunities are for entry level positions. However, it is also recognized that non-entry level positions are likely to have additional requirements beyond a four-year degree from a construction management program.

Construction Management Education

Education provides learners with concepts and theories that can be applied to solve problems while training provides learners with knowledge and experience needed to develop required skills. In contrast to skilled construction workers who often require training but do not need to complete degree programs, construction management education programs are necessary for construction

managers. Construction Management (CM) programs developed in response to the realization that as construction projects became more complex, stronger management skills were needed. Many of these programs evolved from architectural and civil engineering programs while others were offered as a specialty within architectural and civil engineering programs themselves. Architectural and engineering programs tend to focus on design considerations for construction projects while construction management programs focus on business and management principles of the construction projects such as planning, scheduling, estimating, and budgeting [10]. Emphasis on technical, scientific aspects of the construction process varies significantly among construction management programs, so much so that some programs are included within architecture schools or engineering colleges while others are included within business and management schools. Technology to support construction management continues to advance while construction processes and building technologies simultaneously become more complex. The increased complexity of the projects increases the need for formalized education and even creates demand for specialized construction management skills [1]. Therefore, it is important to have construction management education programs that can produce qualified graduates with the requisite skills to meet the growing needs of the construction industry.

Education to Employment Pipeline

It stands to reason that producing a sufficient number of construction management education program graduates who are racial minorities to provide "adequate" minority participation in the field of construction management will require the successful completion of the programs for those minorities enrolled the programs and also by the recruitment and retention of minorities to these programs. Manesh et. al. found that African American students appear to be underrepresented in terms of choosing civil engineering/construction programs and suggest the enlistment of high school counselors by conducting more frequent and widespread efforts to inform them about the strengths of construction/ civil engineering and providing them with information on possible job opportunities and current salary levels. However, African Americans also appear to be less likely to complete the program and earn the degree. Hispanics and Asians chose these programs less frequently but have higher completion rates [7]. It appears that increasing minority participation in construction management may require not only generating additional interest among members of minority groups, but also providing support for successful completion of undergraduate programs.

Methodology

Problem Statement

This descriptive study investigates whether four-year undergraduate construction management programs in Louisiana are producing "sufficient" numbers of minority graduates to support projected construction manager demand. Such an investigation requires that the term "sufficient" be defined. For the purposes of this study, only graduates of four-year construction management programs with Classification of Instructional Programs (CIP) code 52.2001 are considered. Further, sufficiency is defined as "producing a number of graduates greater than or equal to the proportion of graduates that would be anticipated based upon the demographic composition of the defined service area of the institution (i.e., Louisiana)."

In Louisiana, there are three four-year construction management programs with CIP code 52.2001. These programs are offered by Louisiana State University and A&M College (LSU), the University of Louisiana at Monroe (ULM), and the University of New Orleans (UNO). The program at UNO is still in its infancy and has not yet produced any graduates, nor is it accredited. Baton Rouge Community College (BRCC) offers a two-year ACCE accredited construction management program CIP code 52.2001 and Louisiana Tech University offers an ABET accredited four-year degree in Construction Engineering Technology CIP code 15.1001. Data from these programs is not considered by this research. For this study, only the two four-year construction management programs accredited by ACCE in Louisiana offered by LSU and ULM are considered. Because both institutions are public higher education institutions owned and operated by state government, the service area of the institutions will be considered the state itself. It is recognized that the overall graduate production of these institutions may be insufficient to meet the needs of the state itself and this will be briefly considered. However, the intent of this study is to understand minority completion rates for these programs as compared to the minority populations of the state and the demand for minority construction managers.

Data Collection

An extensive literature review of journal articles regarding minorities in construction management was conducted. Information collected from this literature review has been incorporated into the background information of this article. As stated earlier, much of the research regarding minority participation in the construction industry studies skilled labor and trades rather than construction managers. Further, there appears to be no research specific to the growing need for racial minority construction managers. The purpose of this study is to begin to fill in that gap in the body of knowledge.

Data for this study consist of the number of degrees awarded in the geographic area of the study between 2000 and 2021. The dataset contains 14 features and 97608 instances. Among these features are academic year, institution code, institution name, institution level code, institution level name, institution system code, institution system name, degree general, degree level code, degree level name, ethnicity, Classification of Instructional Programs (CIP) code, CIP code name, and Awards. This data combines the numbers of graduates from the LSU and ULM programs. As indicated previously, the UNO program was recently established, is not yet generating graduates, and is therefore not considered in this study. The two-year program at BRCC and the Louisiana Tech program CIP 15.1001 were also not considered.

Data Preprocessing and Feature extraction

Data preprocessing involves cleaning, integrating, transforming, and reducing data dimensions so that they are easier to analyze. This study preprocessed the data by checking for null, duplicate, outliers, missing, and invalid values. In this study, only degrees awarded to graduates of four-year Baccalaureate programs in construction management were considered. After filtering out redundant features, the number of features was reduced to four.

Data Analysis

Exploratory data analysis (EDA) and data virtualization provided insights into datasets, which helped in providing insights to the research questions, and develop modeling approaches. For this study, the Power BI data virtualization tool and 'PivotTables' in machine learning were utilized to visualize charts and graphs, which enabled an accessible way of observing and understanding trends, outliers, and patterns in data.

Time series analysis was performed to see if there is any trend, seasonality, or other patterns in the data and attempt to identify any underlying patterns or relationships. A time series analysis was conducted using the ARIMA model (Autoregressive integrated moving average) in machine learning since this study attempted to forecast only one series at a time. ARIMA is a univariate model that makes predictions based on historical data [11].

There are three main components to ARIMA models: Autoregression, integration and moving average. Autoregression models the relationship between present and past values, integration make the data stationary so statistical models can be used that assume a constant mean and variance. Moving Averages (MA) model the relationship between error terms and past values [12]. The ARIMA model was fitted to historical data to make predictions about future time series values, and its coefficients were estimated using maximum likelihood estimation.

Results and Discussion

For easier analysis, the ethnicity feature of the data is divided into two categories: Minority and White non-Hispanic. Graduates in each category are reported each year, and total for each category over time. As shown in Figures 1 and 2, White, Non-Hispanic graduates had the highest total number of graduates at 2757, 137,750.00% higher than Native Hawaiians or other Pacific Islanders, which had the lowest total number of graduates [13]. Figure 3 shows Program One produced the most graduates at 2815 [13].

There has been an increase in graduates for both minorities and white non-Hispanic groups over the years as seen in Figure 4 [13]. However, minority graduates have consistently been below those of white non-Hispanics. There has been a significant gap between minority graduates and white non-Hispanic graduates in recent years, with 41 minority graduates in 2021 compared to 224 white non-Hispanic graduates as seen in Table 1. This indicates that there are ongoing disparities in education and opportunities for minorities.

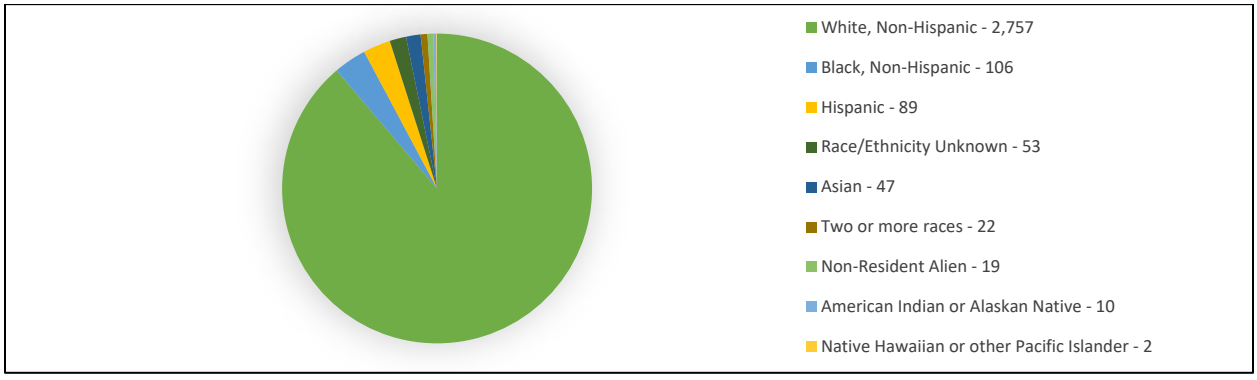
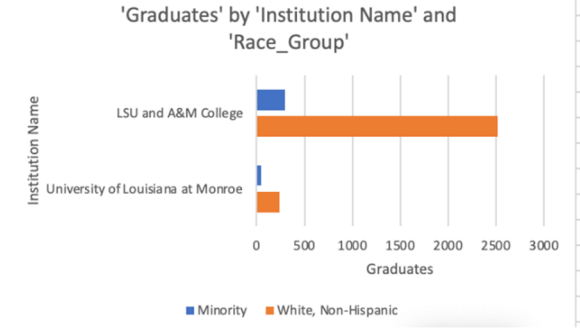


Figure 1. Total Diversity breakdown of construction management graduates [13]



Sum of Graduates	Race_Group		
Institution Name	Minority	White, Non-Hispanic	Grand Total
LSU and A&M College	299	2516	2815
University of Louisiana at Monroe	49	241	290
Grand Total	**348**	**2757**	**3105**

Figure 2. Diversity breakdown by institution name [13]

	Graduates		
Race_Group	Minority	White, Non-Hispanic	Total
Year			
2003-01-01	13	132	145
2004-01-01	7	137	144
2005-01-01	12	141	153
2006-01-01	5	126	131
2007-01-01	7	139	146
2008-01-01	11	141	152
2009-01-01	11	145	156
2010-01-01	15	142	157
2011-01-01	16	125	141
2012-01-01	21	114	135
2013-01-01	20	125	145
2014-01-01	11	110	121
2015-01-01	16	115	131
2016-01-01	20	136	156
2017-01-01	31	166	197
2018-01-01	28	183	211
2019-01-01	31	175	206
2020-01-01	32	181	213
2021-01-01	41	224	265
Total	348	2757	3105

Table 1. Number of graduates from 2003-2021 [13]

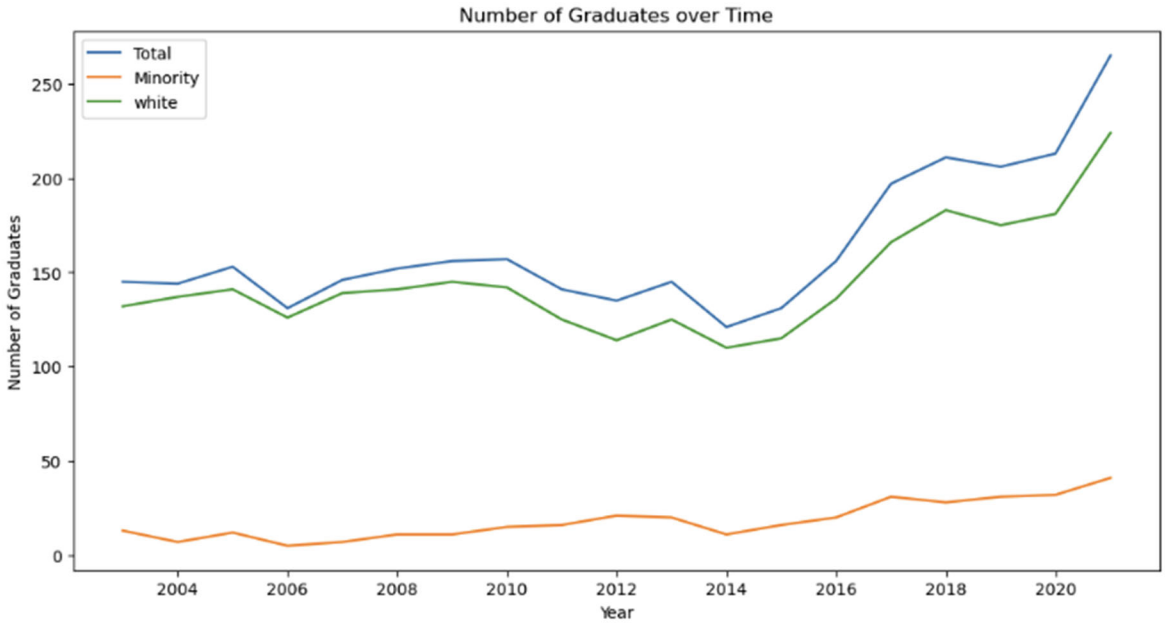


Figure 3. Trend of number of graduates from 2003- 2021 [13]

Using a time series approach, Figure 3 illustrates that the total number of graduates over time has steadily increased. This indicates that there has been a steady increase in total graduates over time. Furthermore, it is apparent from the graph in Figure 3 that minority graduates have consistently been lower than white non-Hispanic graduates over time. Moreover, while the number of white graduates has remained relatively stable over time, the number of minority graduates has displayed a high degree of variability. This is due to some years showing significant increases or decreases. The time series data can be decomposed into trends, seasonal, and residual components to identify potential seasonal patterns. According to the decomposition results, a clear upward trend is evident in the number of graduates over time, although seasonal fluctuations exist. However, there is no consistent seasonal pattern for the number of graduates by ethnicity.

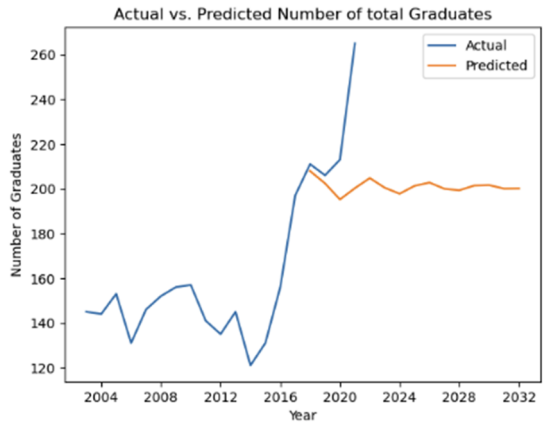


Figure 4. Actual vs. Predicted Number of Total Graduates [13]

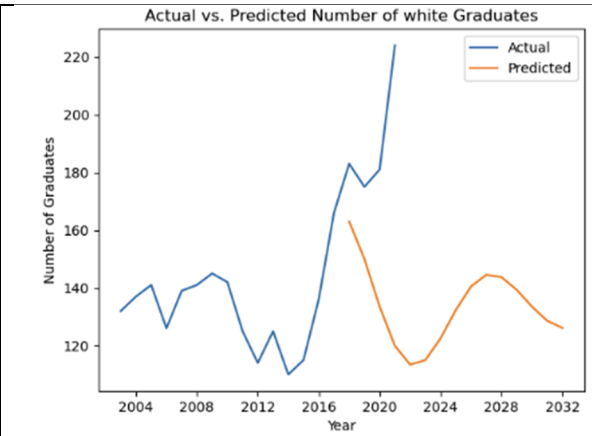


Figure 5. Actual vs. Predicted Number of White Graduates [13]

Year	Graduates	Minority	White, Non-Hispanic
2018	208	30	163
2019	202	31	150
2020	195	31	134
2021	200	31	120
2022	205	31	113
2023	200	31	115
2024	198	31	123
2025	201	31	132
2026	203	31	141
2027	200	31	145
2028	199	31	144
2029	201	31	139
2030	202	31	134
2031	200	31	129
2032	200	31	126
Total	3014	464	2008

Table 2. Predicted number of Graduates [13]

Table 2 shows the number of graduates predicted by the ARIMA model. The plots shown in Figures 4 through 7 show the actual values, the predicted values, and the 95% confidence intervals for the predicted values for the entire time series, including the forecast. As is evident from the graph, the total population has steadily increased over time, with some fluctuations. Consequently, the minority population has also steadily increased over the years, but at a slightly faster rate than the number of graduates. It is expected that the total number of graduates will continue to increase, although at a slower rate, based on the time series forecasting analysis. Similarly, the number of minority graduates is expected to increase at a similar rate, leading to an increase in the number of minority construction managers in the future. Consequently, there is a possibility that the number of white graduates will continue to decline, which may have implications for issues such as representation, diversity, and social dynamics.

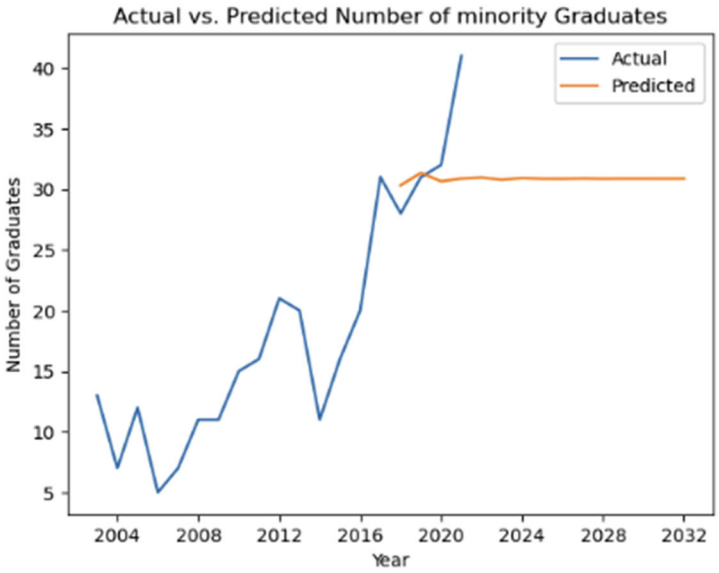


Figure 6. Actual vs predicted number of minority graduates [13] and ARIMA model.

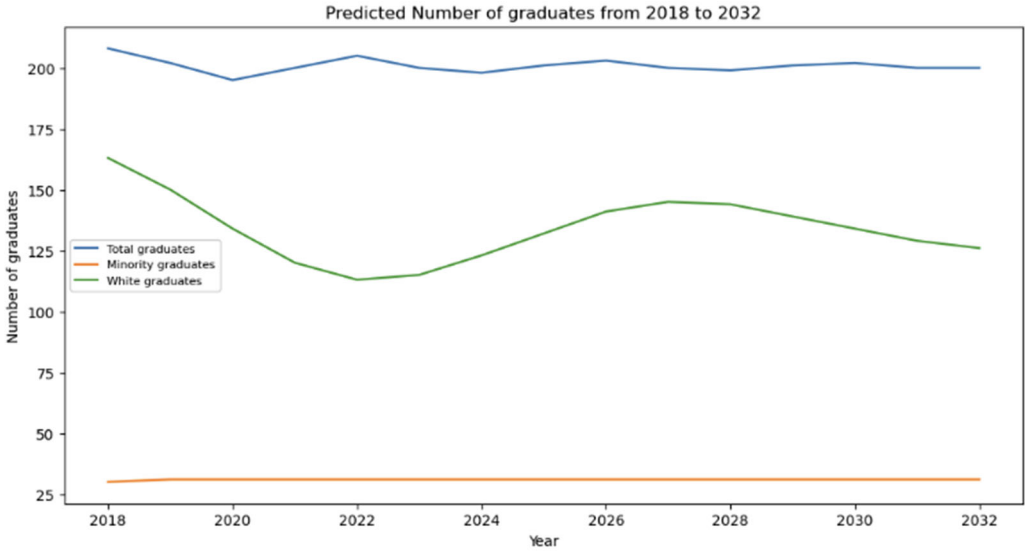


Figure 7. Predicted number of total, white, and minority graduates from ARIMA model

Finally, this analysis of data and time series provided some insights into the changing demographics of construction managers in the subject geographic service area. Nevertheless, many factors can affect population trends, such as birth rates, migration, and government policies. Therefore, a more comprehensive analysis would require a deeper understanding of these factors and their potential impacts on population dynamics.

Conclusion and Recommendations

In the US, the demographics of employed construction managers continue to skew heavily to white males. The demographics of construction management education graduates also skew heavily to white males. The ARIMA model developed for this study predicts that this trend will continue throughout the study period to 2031. Despite recent spikes in the number of overall construction management graduates, the data suggests that these increases are the result of increasing numbers of white graduates while the number of racial minority graduates has increased modestly. Further, the percentage of racial minority graduates (approximately 15.4%) seems disproportionately low when compared to the estimated percentage of the statewide population identifying as racial minorities (37.6%) [14] and does not appear to be representative of the subject geographic area.

This study considers two specific undergraduate construction management education programs. Additional research is required to determine if this trend can be observed in other states or regions of the country and/or nationwide. Future studies should also consider production of women construction management graduates and racial and/or ethnic minority women construction management graduates.

Another limitation of this study is that it considers only four-year, accredited construction management education programs. It does not consider two-year or graduate construction management programs, unaccredited programs or programs with differing titles and specializations which might lead to careers in construction management such as construction engineering, construction engineering technology, project management or civil engineering. Such programs could be included in future research to determine if the pool of graduates qualified for entry level construction management positions is larger than anticipated in this study.

This study also does not seek to determine factors contributing to the limited number of minority graduates. Additional study of those factors is warranted. Although data was reviewed from the U.S. Department of Education's National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS) databases in addition to data provided by the subject schools, the data analyzed for this study did not include enrollment or retention rates because the schools did not report or publish those rates specifically for their construction management programs. Exploration of the existence of a relationship between minority enrollment and minority graduation rates could prove useful as it is unknown if the number of minority graduates reflects low participation or low completion in the subject programs.

The Louisiana Workforce Commission estimates that the need for construction managers will increase by 1,024 openings between 2020-2030 [15]. While based on the model developed it appears that the demand for construction managers through 2030 can be met by the two subject construction management programs, the model also suggests production of minority construction management graduates will remain flat. The model predicts 310 minority construction

management graduates between 2020 and 2030. However, based on the state's minority population, 385 minority construction management graduates would be needed for sufficiency as defined in this study. For now, the number of racial minority construction management graduates seems insufficient.

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