An Exponential Model for Manpower Planning in the Australian Construction Industry

Oluwole Alfred Olatunji
Senior Lecturer| Department of Construction Management, School of Built Environment, Curtin University, Australia| oluwole.olatunji@curtin.edu.au.

Abstract
This study presents a critical review of methods and tools used for predicting manpower demand within the Australian construction industry. Between 2001 and 2015, only two out of the 20 sectors reported by the Australian Bureau of Statistics have contributed a little more than construction in terms of sectoral GDP and real growths. Heading to the future: Australia has had an ambitious infrastructure plan. There is commitment to build bigger and better infrastructure and to repair loads of existing stock. These require highly skilled workforce in the appropriate grade and number. Australia has had to rely on construction skill imports to this day! A small rise in construction and infrastructure spending would mean that more workers are needed in the construction sector. Even if the spending remains unchanged from previous years', the construction sector has had a significant proportion of aged, and ageing, workforce that requires replacement at now or at some stage. First, this study will explore the appropriate number of construction workers needed to maintain consistent growth within the Australian construction industry in the next 15 years. Historical data from the Australian Bureau of Statistics were analyzed. A polynomial model is developed. One percent rise in Construction GDP will require *y* number of workers, predicted by $-0.0000008x^2 + 0.0182x - 181.06$ ($R^2 = 0.938$; $R=0.968$); where *x* is Seasonally Adjusted Construction GDP (in AUD). Findings will help policy makers and researchers on how to deal with labor issues in the industry.

Keywords: Australia, construction GDP, infrastructure, manpower planning, policy

1. Introduction

The purpose of this paper is to present a critical review of methods and tools used for predicting manpower demand within the Australian construction industry. There is no denying the Australian construction industry is a major contributor to the growth of Australia's economy. In the last years, the Australian construction industry contributed nearly eight percent of Australia's GDP annually. Between 2001 and 2015, only two out of the 20 sectors reported by the Australian Bureau of Statistics have contributed more than construction in terms of sectoral GDP and real growths– and these are Mining and, the Finance and Insurance sectors (see Australian Trade Commission (2016). If at all, the difference between the Australian construction industry and these sectors is only marginal. For example, in 2014 – 2015, the share of the Mining sector in Australia's real growth is 9.3 percent; Construction, 8.2 percent. On a longer term, between 1991 and 2015, the Australian construction industry accounts for 4.6 percent real growth in the economy every year; Mining, 4.4 percent. In terms of jobs, in 2015, evidence from the

Australian Bureau of Statistics' data[5] shows the Australian construction industry provides jobs for 8.9 percent of total number of employed persons in Australia; Mining, 2 percent. Now, pundits say the best of the Australian Mining sector is possibly over (see Edwards, 2014 and Humphreys, 2010). It is only logical that policy makers consider the potential impact of negative trends in the Australian mining sector on the health of Australia's larger economy. For example, as global economy slows down and the incentive for increased production plummets, significant job losses is anticipated (Corden, 2012). The construction sector could be a comfortable home for out-of-job mining workers.

A small rise in construction and infrastructure spending would mean that more workers are needed in the construction sector. Even if the spending remains unchanged from previous years', the construction sector has had a significant proportion of aged, and ageing, workforce that requires urgent replacement. More importantly, Australia's infrastructure demand is an unprecedented increase. Australian population is expected to exceed 30 million by 2031. Figure 1 shows some ongoing and projected infrastructure projects that are expected to be completed by 2013. This translates into significant increase in construction and infrastructure spending, consistently every year, from now beyond 2031. New assets need to be built bigger than before, old stock need to be upgraded; the required innovation and complexity are expected to increase. As a result, Australia requires some massive reforms on manpower supply into the construction industry. These relate to the uniqueness of the skill level, the level of productivity, advance techniques and technologies, and the appropriate amount of manpower.

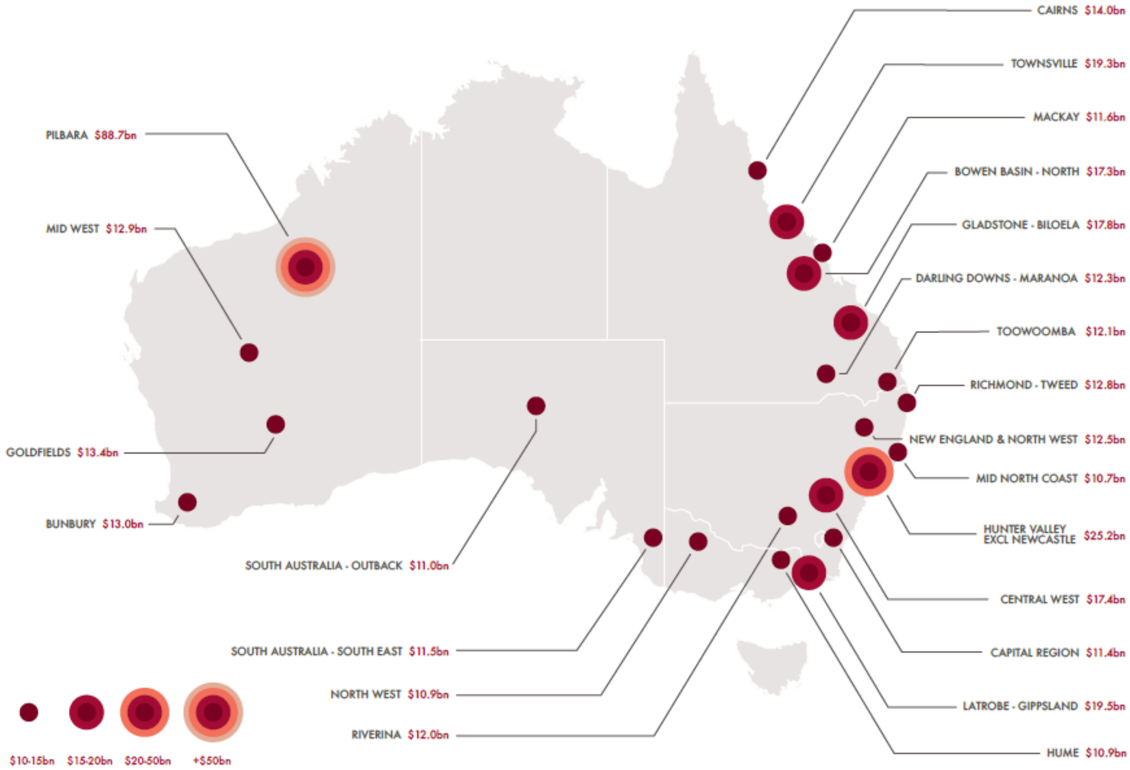

Figure 1: Projected new infrastructure projects to be completed by 2031 (by Australian Infrastructure Audit, 2015). Source: Infrastructure Australia (2016:61)

What is the appropriate number of construction workers needed to maintain consistent growth within the Australian construction industry? 2031 is some fifteen years away, however most useful strategic models focus on quarterly and yearly manpower supply plans (Ho, 2010 and Wong et al, 2004). How do researchers and policy makers predict and manage manpower supply in the Australian construction industry? How much of these tools and methods remain reliable as the nation heads into its classic construction and infrastructure future? This study focuses on reviewing methods and tools used for

[5] Catalogue No 6291.0.55.003 Labour Force Australia, Detailed, Quarterly, Table 4.

predicting manpower supply in the Australian construction industry.

2. Manpower forecasting: Planning Tools and Methods

There is no shortage of knowledge in normative literature regarding the economic importance of the construction industry, whether locally or globally. According to Hillebrandt (2000), construction creates jobs: in Australia, Construction is one of the very few sectors with consistent positive change in job numbers year after year. According to Australian Bureau of Statistics' YearBook published in 2007, every $1million spent in construction has a roll-on effect of $2.9 million; every 9 jobs in construction has a roll-on effect of 37 projects in the economy. Meanwhile these are conceptual projections, with a clear gap on the relationship between construction expenditure and jobs. The work of Ball and Wood (1995: 307) is emphatically clear on this. Using data from the United Kingdom, their study points out there is only a weak relationship between additional construction expenditure and rise in employment. In addition, another dimension to the ABS's model is that the true value of $1 amount will not remain the same forever, and construction activities and productivities are vulnerable to seasons, varying government policies, macro-economy variabilities and construction technologies (see Baloi and Price 2003 and Olatunji 2010). As result it is fundamentally misleading to model manpower requirement of the construction industry only on the basis of total or on additional dollar amount spent. This is because the relationship between the two is simply not linear. Construction estimators know this: certain aspects of construction activities only require intensive labor, whilst others require intensive equipment and or expensive materials (see Brook, 2012; and Harris et al., 2006). Invariably, some low cost projects can employ more people than other projects where cost is much higher.

There are many other models for predicting manpower supply in the construction industry. Wong et al., (2004) summarize these into four:

- **Time-series forecasting** approach, an extrapolation method that rely only on the relationship between time and previous achievements. Whether as linear modelling, stochastic modelling or exponential smoothing, adopters of time series forecasting approach only need to evaluate and compare historical data with recent observation, both with different weightings. As a result, they are best for short-term predictions. A major limitation of the approach is that it neither considers factors that triggers change patterns nor explains deviations from history. If observation patterns are not a continuum, for example like the impact of an economic recession or a radical change in business approach and construction method, the approach does not provide explanatory reasoning.
- **Market signalling** approach, which is based on market demand for labour based on indices like job advertisements, number of recent graduates, demographic distribution of existing workforce and so like. The approach only considers previous achievements, and there is only a limited statistical correlation between the variables being measured and actual job needs in the industry.
- **Top-bottom** approach, in which policy makers make projections on their perceived need of the economy. Such projections are often conceptual rather than being based on actual industry demands.
- **Bottom-up** approach, in which construction businesses articulate their skill needs based on present situations. Such needs are then articulated for future supply

3. Method

The main objective of this study is project the number of jobs required in the Australian construction industry is there is one percent growth in construction GDP. This analysis will focus on employments from construction sector and possible general impacts in other sectors of the economy. First of all, it is necessary to compare the relation between construction growth rate and employment growth rate from construction, which is showed in Figure 2. As can be seen, there is not a regular or similar variation in both rates in the last 15 years. However, a similarity is the positive values in the vast majority of time that indicates a constant growth in these aspects.

Figure 2 - Comparing Growth Rates

The projection will be based in two statistical methods: polynomial and linear regression methods. Best behavior parameters of the two models, based on data from the past 15 years, were obtained.

4. Findings and Discussion

Using the software SciDavis to interpolate the data was found the curve showed in Figure 3. A polynomial model is developed as $y = -7E\text{-}08x^2 + 0.0182x - 181.06$; ($R^2 = 0.938$, R=0.968). R^2, an adjustment measure, shows the extent to which the dependent variable y is related to the independent variable x. Construction employment, in this case is dependent on construction GDP as seasonally adjusted. 93.8% of the ordinate variable can be explained by the independent variable. In addition, R, the correlation coefficient, measures the degree of dependence and the correlation between both variables. The value, 0.968, indicates a strong correlation in this analysis. Then, designing the construction GDP to one percent over 2015 ($126,166 million), the construction GDP to 2016 will be $127,427 million. This means a growth of $1.261 billion in construction industry. Utilizing the supposed value to 2016 construction GDP in the polynomial equation in Figure 3, only a total of 1,001.47 thousand jobs exist in the construction. This implies, despite a one percent rise in Construction GDP in 2016, about 45 thousand jobs will be lost. As shown in Figure 3, the negative scenario is as a result of a mild recent recession.

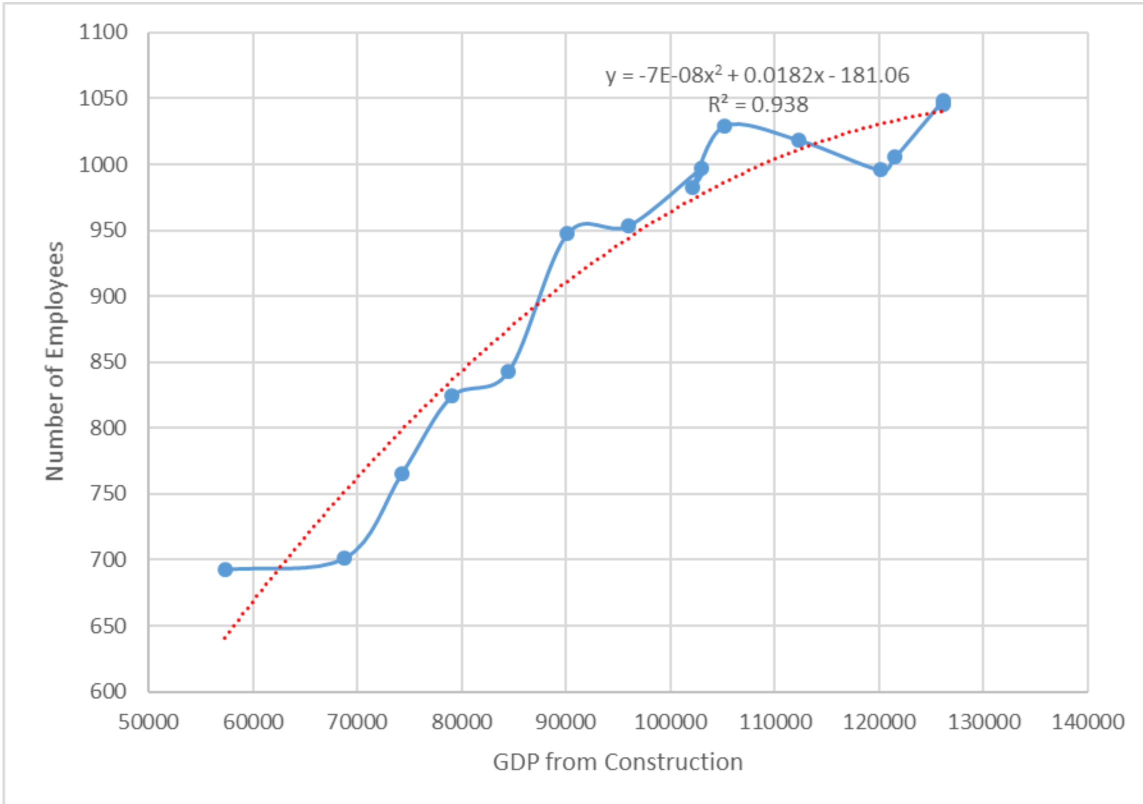

Figure 3 - Analysis Polynomial Second Degree

A linear regression model was also obtained as y = 0.0054x + 397.38; R^2 = 0.8825; R=0.94. The findings mean that this curve still fitting well to the data and do not refutes this analysis. So, repeating the process of putting the one percent growth in GDP construction over 2015 in this second equation, will be found 1085.48 thousand people employed in the construction sector in next year. It means an increase of 39.4 thousand jobs in construction industry.

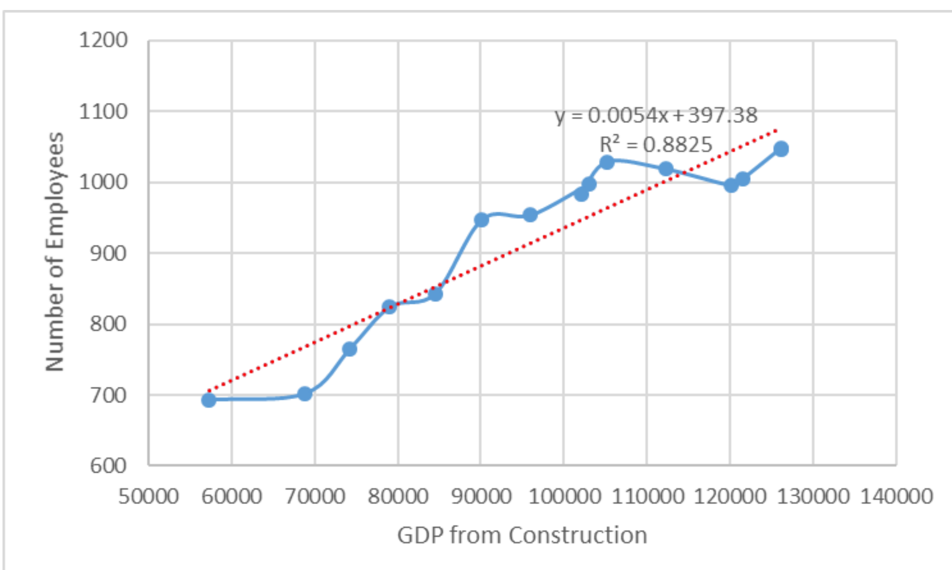

Figure 4 – Linear Regression

Besides the increase seen in the number of jobs already, other impacts in the economy should be analyzed. The first step is divide the employed people according to their skill level of occupation. According to ABS (Australia Bureau Statistics) skilled level jobs are classified as follow:

- Skill Level 1 is commensurate with a Bachelor degree or higher qualification
- Skill Level 2 is commensurate with an Advanced Diploma or Diploma
- Skill Level 3 is commensurate with a Certificate IV or III (including at least 2 years on-the-job training)
- Skill Level 4 is commensurate with a Certificate II or III
- Skill Level 5 is commensurate with a Certificate I or secondary education

Using the percentage job per skill from 2015, was realized a projection to the next year. Some examples of occupation in each skill level from construction sector was used as example with its respective salary. The objective of this process is found an average salary and observe the impact on Australia economy. The results are showed in the Table Y, the average salary found was $ 1335.2 per week. It means $ 5,389,243.24 more circulating on the Australia economy per week. In addition, to have an idea about impacts in other sectors, was used average expenditure of the population in various sectors as showed in table'. Hence, construction growth will directly impact other sectors of the economy just by analyzing expenditures of new employed people. For example, new employees will spend $ 2,377,733.97 on the transport sector, it means a significant impact to this sector.

5. Conclusion

Increasing 1% in the construction GDP sector can represent a considerably change in the total GDP growth-rate of Australia. The relation between the numbers in the data collected was unclear. To analyze the collected data, the interpolation among construction growth GDP and the number of employees was done using the SciDavis, a software that provides formulas and curves. To have a more accurate analysis, a linear and a polynomial curve were used and compared, and also some different results were found. Using the polynomial line, which gave a more accurate curve, the result is not positive, presenting a decrease in the employment rate. On the other hand, when using a linear curve, the impact of employment is positive, presenting a growth on it. This increase can impact positively the economy. The number of employed people impacts considerably the expenditure, what means more money circulating in the country. This money circulation improves the economic growth of the country. However, a great problem in the construction sector, such as other sectors, are the ethical issues, that can represent a great problem in the economic advances. The construction sector plays a great role in the Australia`s economy, and the growth rate of 1% in this sector can impact considerably other sectors, due to the increase in money circulating. Furthermore, once is a great weapon to develop the economy, to increase the construction sector, the problems relating to ethical issues need to be looked into. Developing the construction sector, rising the number of employment and solving the problems related to the corruption on the construction sector, Australia can increase its economy. Hence, generating also more employment in other sectors and doing more money circulating, it means a more powerful economy.

References

Australian Bureau of Statistics (2007). "YearBook Australia 2007," http://www.abs.gov.au/ausstats/abs@.nsf/3d68c56307742d8fca257090002029cd/ed6220072793785eca256b360003228f!OpenDocument

Australian Trade Commission (2016). "Why Australia: Benchmark Report." Australian Government, Canberra.

Ball, M., and Wood, A. (1995). How many jobs does construction expenditure generate? *Construction Management and Economics* **13**, 307-318.

Baloi, D., and Price, A. D. F. (2003). Modelling global risk factors affecting construction cost performance. *International Journal of Project Management* **21**, 261-269.

Brook, M. (2012). "Estimating and tendering for construction work," Routledge.

Corden, W. M. (2012). Dutch disease in Australia: policy options for a three-speed economy. *Australian Economic Review* **45**, 290-304.

Edwards, J. (2014). "Beyond the boom," Penguin Group, Melbourne, Victoria.

Harris, F., McCaffer, R., and Edum-Fotwe, F. (2006). "Modern Construction Management," Sixth/Ed. Blackwell Publishing, Oxford, UK.

Hillebrandt, P. (2000). "Economic Theory and the Construction Industry," Macmillan, London.

Ho, P. (2010). Forecasting Construction Manpower Demand by Gray Model. *ASCE Journal of Construction Engineering and Management* **10.1061/(ASCE)CO.1943-7862.0000238**, 1299-1305.

Humphreys, D. (2010). The great metals boom: A retrospective. *Resources Policy* **35**, 1-13.

Infrastructure Australia (2016). "Australian Infrastructure Plan: Priorities and reforms for our nation's future." Commonwealth of Australia.

Olatunji, O. A. (2010). The impact of oil price regimes on construction cost in Nigeria. *Construction Management and Economics* **28**, 747-759.

Wong, J., Chan, A., and Chiang, Y. H. (2004). A Critical Review of Forecasting Models to Predict Manpower Demand. *Australasian Journal of Construction Economics and Building* **4**, 43 **-** 56.