Program for the Task Allocation Model: Integrating Workforce Planning for Manpower Utilization at City of Cabuyao Engineering Office

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***Abstract*—The City Engineering Office has such a great deal of difficulty completing projects, and when new ones come up, the work piles up. The results of a survey of 7 individuals who work for the program for projects on the causes of pending allocation delays indicate that labor capacity of the engineering office is one of the most significant factors in increasing pending allocation. The right quality and number of people are required for firms to successfully implement strategic planning. It requires the correct quantity of workforce with the right skills and talents at the appropriate times, in proper position, and for the cheapest price, among other things. Through an Integrated Workforce Planning Model, the proponents are led to the intervention of an allocation system through the use of Excel Visual Basic Application. The data collected was used and analyzed in order to build the system by considering the workforce analysis, computation of utilization points based on the set parameters of budget and estimated duration and the current classified description of the construction projects at the City Engineering Office. It was found out that workforce planning was an effective tool for optimizing the capacity of people working on programs to meet the demands of construction projects.**

Keywords—utilization, workforce planning, gaps, allocation, program of works

I. INTRODUCTION

In working on the Program of Works for the planning and design of construction projects at the City of Cabuyao Engineering Office, there are instances that the completion is slow and when new projects come, the work piles up. Following this, projects that are significant for the city's needs were not being allocated and worked on immediately.

The instances of the arrival of multiple construction projects present the need to ensure a workforce's availability and allocate the tasks effectively to the personnel. The discrepancy in the projects allocated to each person in charge presents a need to utilize the workforce capacity and balance the workload for the personnel.

Labor is vital to any business. However, it is underutilized in planning, estimating, and optimization. The lack of a defined standard for workforce planning outcomes and an effective workforce planning and forecasting technique appears to be the most likely cause of the apparent gap between goal and implementation. Effective workforce planning is one of the most important factors for both manufacturing and service firms since this has a significant impact on the efficiency of the day-to-day operational processes and the quality of services that are offered by a firm.

II. CONCEPTUAL FRAMEWORK

Fig 1. Conceptual Framework of the Study

The conceptual framework presents the processes that willbe undertaken for the study. In setting the strategic plan, the current situation, and the existing problems in the delay of execution of the program for the project task at the City of Cabuyao Engineering Office and the factors contributing to the increase of pending projects will be determined. The workforce analysis will indicate the capability of the office to work on the program for the project of multiple projects while the workforce demand will state the projected construction projects where the manpower will be allocated.

II. METHODOLOGY

A. Research Design

This research adopted a mixed methods research design, a strategy for gathering, assessing, and combining both quantitative and qualitative research and methodologies in a single study. The proponents used a survey research design incorporating both the quantitative research strategies with numerically rated items on questionnaires and qualitative research strategies through the utilization of open-ended questions.

B. Sampling Design

This study used a non-probability sample that is chosen based on the population's characteristics and the study's objectives. The proponents used the total population sampling to investigate the complete population that shares one or more common traits.

C. Research Instrument

1. Workforce Planning

   It is the process of analyzing, forecasting, and planning workforce supply and demand, identifying gaps, and determining target talent management interventions to ensure that an organization has the right people in the right places at the right time to fulfill its mandate and strategic objectives.

2. Semi-Structured Interview

   The semi-structured interview includes a mix of closed- and open-ended questions, frequently supplemented by follow-up why or how inquiries, this was used conversationally with the respondent to gather the required qualitative data for the study.

3. Survey Questionnaire

   This was used in gathering information from personnel and other significant positions that handle the processes of completing the program for the project.

4. Flowchart

   Flow Chart defining used to assess the existing process, and identified the areas for improvement, such as gaps, in the process.

5. SWOT Diagram

   The SWOT diagram are used for understanding the problem, and aid strategic planning and decision-making. It also provides useful insights on exploring new attempts, determining where change is possible, and revising and refining plans in the middle of the process.

D. Statistical Treatment of Data

1. Mean Absolute Percentage Error (MAPE)

The absolute error in each period is divided by the recorded values for that period to obtain the MAPE. After that, take the average of those predetermined percentages. This approach is useful when the size or magnitude of a prediction variable is significant in evaluating the accuracy of a forecast.

$$MAPE = \frac{\sum \frac{|A_t - F_t|}{A_t}}{n} \times 100\%$$

Wherein:

A_t = Actual Value
F_t = Forecast Value
n = number of times the summation iteration happens

Forecast Accuracy refers to how accurate a forecast is. It's computed such as this:

$$\text{Forecast Acurracy} = 1 - \left(\frac{Actual - Forecast}{Actual} \times 100\right)$$

2. Weighted Mean

The proponents used weighted mean to determine the impact of the factors contributing to pending allocation of projects using Likert scale.

$$\bar{x} = \frac{\sum x \cdot \mathrm{f}}{\sum \mathrm{f}}$$

Wherein: $\bar{x}$ = mean of sample
f = frequency

III. RESULTS AND DISCUSSION

This section discusses the evaluation and analysis of data obtained from the City of Cabuyao Engineering Office, the interpretation of survey and interview results, and the breakdown of instruments used to better understand the study at hand.

A. Factors Contributing to Pending Allocation of Construction Projects

TABLE 2. FACTORS IN INCREASING PENDING ALLOCATION OF PROJECTS

Factor Number	Factors in Increasing Pending Allocation of Projects	Mean	Likert Scale Description
1	Complexity of Project	3.14	Average Effect
2	Lack of Expertise on advanced engineering design software	3.14	Average Effect
3	Lack of preparedness on seasonal construction projects (example before the election)	3.29	Average Effect
4	Labor capacity of engineering office	3.57	High Effect
5	Availability of person-in-charge/team	2.71	Average Effect
6	Lack of utilization of multi-skilled workers	2.71	Average Effect
7	Bureaucracy and changes of government regulations	2.86	Average Effect
8	Changes in scope of the program of works	3.43	High Effect
9	Poor communication and coordination	3.29	Average Effect

An analysis of the factors that contribute to the increase in pending project allocations. The factor with the highest mean score is "Labor capacity of engineering office" with a mean score of 3.57 and a high effect level of the mean value. Also, the factor "Changes in the scope of the program of works" received a 3.43 mean score and a high effect level.

The report, published by the Business Development Bank of Canada (BDC), combines the results of two polls and concludes

that 49% of business owners have had to delay or cancel deliveries to customers due to a lack of labor [1].

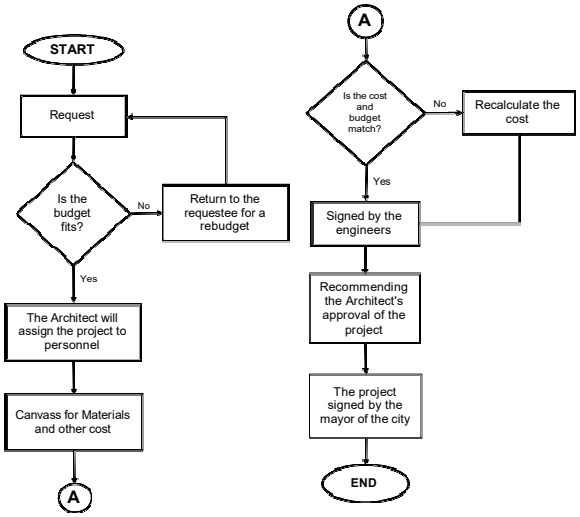

Fig. 2. Process Flowchart for Allocating Minor Projects

Figure 1 shows the Process flowchart for allocating minor projects. The requester will submit a letter of the proposed project to the engineering office. To approve their request, the budget must be fit for the project and if not, the engineering office will send it back to the requester for re-budgeting. Once the budget is settled, the architect will assign the project to the personnel, then it will sign by the city mayor.

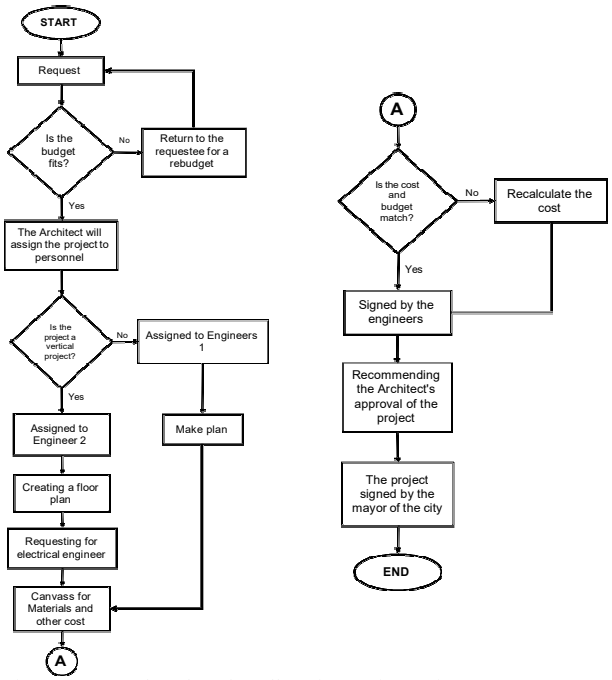

Fig. 3. Process Flowchart for Allocating Major Projects

The Process flowchart for allocating major projects. The requester will submit a letter of the proposed project to the engineering office. The office will identify if it's vertical or horizontal type of construction. The collaboration of personnel from construction engineer to electrical engineer Then the canvassing of materials, therefore, budget must be fit for the project and if not, it will send back to the requester for re-budgeting. Once it settled the office-in-charge will recommend it to mayor's office for signatory.

B. Significant Difference between Workforce Capacity and Workforce Demand

a. Workforce Analysis

TABLE 2. BACKGROUND INFORMATION OF PERSONNEL AT CITY ENGINEERING OFFICE

Personnel	Position in Company	Experience (Years)	Level of Education	Licensed
1	Draftsman	14 yrs	Bachelor's Degree	No
2	Engineer 1	39 yrs	Bachelor's Degree	Yes
3	Engineer 2	Almost 8 yrs	Bachelor's Degree	Yes
4	Engineer 1	5 yrs	Bachelor's Degree	Yes
5	Engineer 1	-	Bachelor's Degree	Yes
6	Draftsman, Estimator and Estimator	18 yrs & 7 mos	Bachelor's Degree	No
7	Engineer 3 and Estimator	6 yrs & 5 mos	Bachelor's Degree	Yes

Table 2 shows the background information of personnel in City Engineering Office it has seven employees that are responsible for the program of work. Engineers, architects, draftsman/AutoCAD Operator, Estimator, and Construction Foreman are among them. Each employee's strategy for determining who should oversee a specific project is based on their talents, capabilities, and experience working for a program for works.

b. Demand Analysis

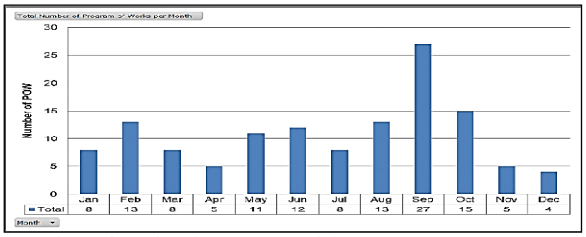

Fig. 4. Total Number of Projects per Month in 2021

The number of projects fluctuates in September and October with 25 and 15 total projects respectively. In these months, aside from renovations and constructions, the number of repair works goes up leading to an increase in the demanded workforce. The least number of total projects sets in December but is composed of 4 construction works.

Cited to Robert Handler, Distinguished VP Analyst at Gartner, the problem is mostly caused by poor use of existing resources, while a shortage of resources can be created by a lack of certain abilities or an actual shortage of numbers [2].

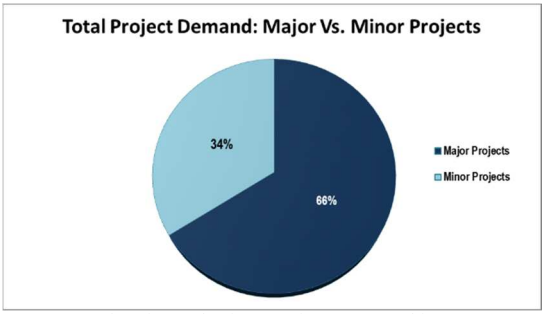

Fig. 5. Percentage of Major and Minor Projects Demand in Year 2021

The total demand in the year 2021 based on the tabulated data tallied up to 183 total government construction projects. It is mostly composed of major projects that have a total of 121 which amounted to 66% of the total project demand. On the other hand, minor projects have a total percentage of 34% which is almost half of the value of the major projects. The pie graph indicated that more complex projects are being assigned to personnel working on the program of works.

c. Supply and Demand Gap Analysis

TABLE 3. SUPPLY AND DEMAND GAP ANALYSIS FOR MAJOR PROJECTS

Month	Major Project (New)	Total Demand in Month	Major Project (Completed)	Gap	Gap Percen-tage
January	10	15	8	7	47%
February	15	22	14	8	36%
March	12	20	16	4	20%
April	7	11	8	3	27%
May	11	14	10	4	29%
June	13	17	10	7	41%
July	12	19	11	8	42%
August	10	18	1	17	94%
September	22	39	26	13	33%
October	7	20	18	2	10%
November	2	4	4	0	0%
Average	**11.00**				**35%**

Table 3 presents the breakdown of major project demand coming into the Cabuyao City Engineering Office for each month in 2021. There is an average of 11 major project demands being allocated. In September, however, the largest margin was 17. The computed average gap indicates that for each month 35% of the demanded major projects are not being completed. The range of the new major projects per month is equal to 20 which have been calculated using the minimum and maximum values, 2 and 22 respectively.

TABLE 4. SUPPLY AND DEMAND GAP ANALYSIS FOR MINOR PROJECTS

Month	Minor Project (New)	Total Demand in Month	Minor Project (Completed)	Gap	Gap Percen-tage
January	4	8	2	6	75%
February	7	13	4	9	69%
March	2	11	7	4	36%
April	1	5	0	5	100%
May	6	11	11	0	0%
June	7	7	5	2	29%
July	2	4	1	3	75%
August	8	11	1	10	91%
September	15	25	6	19	76%
October	9	28	21	7	25%
November	1	8	8	0	0%
Average	**5.64**				**52%**

The monthly breakdown of minor project demands received by the Cabuyao City Engineering Office in 2021. A total of 11 minor project demands are allocated on average. However, the largest gap shown in September was 19. According to the calculated average gap, 52 percent, or more than half, of the demanded minor projects are not completed each month. The range of the new major projects per month is equal to 14 which have been calculated using the minimum and maximum values, 1 and 15 respectively.

TABLE 5. DEMAND AND SUPPLY ANALYSIS

Months	Total Average Duration (Days)	Required FTE per Month
January	114.54	6
February	**176.785**	**9**
March	113.34	6
April	79.285	4
May	137.115	7
June	133.155	7
July	137.14	7
August	108.885	5
September	271.355	13
October	129.67	6
November	72.27	4
December	77.14	4
Grand Total	**1550.68**	...

Note: Currently there are 7 personnel working on POW, Therefore, engineering office can only supply 154 working days per month.

The supply and demand analysis assumes that one employee has only 22 working days per month and that the required FTE has a total average duration of 22 working days. September has the most working durations (271.335), implying that 13 employees are required. The following month with the largest number of FTE required is February, with a total average duration of 176.785 days and a need for 9 people to work on the program of work. The months of May, June, and July had the required number of personnel, which is 7 personnel. In January, followed by March, and October, requiring only six personnel. While in August, which has only 5 needed FTE per month, and the lowest FTE required per month is the month of April, November, and December.

Gustomo et al. and Chen et al. found in their studies that the employees in the organizations investigated had high workloads and thus suggested the need to redesign jobs or employ additional workers [3].

C. Significant Parameters in Utilization of Manpower for the Program of Works at the Office

TABLE 6. AVERAGE ALLOTTED BUDGET PER DESCRIPTION OF CONSTRUCTION PROJECTS

Description	Average of Allotted Budget (Php)
Construction	11,659,407.11
Embankment	8,301,806.80
Embankment/Construction	2,989,646.23
Renovation	849,342.60
Fabrication	507,454.12
Extension	465,837.69
Installation	429,780.43
Repair/Cleaning	343,435.74
Repainting	224,869.98
Repair	214,145.63
Installation and Fabrication	101,459.61

The values of the average allotted budget for each stated description. The values signify the discrepancy in the allotted budget for a certain description. As it is considered the triple constraint in construction projects, the project cost is the initial basis for describing how big or small a project is and also a measure of the amount of effort that must be put into completing the planning for its program of work. The budget defines the scope of a project and determines the workload that it will require to fulfill the goals of the project.

TABLE 7. AVERAGE DURATION FOR PROGRAM OF WORKS OF MAJOR PROJECTS

Description	Average Duration (Weeks)
Construction	3.9
Extension	2.1
Renovation	1.9

The table presented the highest duration for completion of program for major projects which comprises of construction works with 3.9 weeks. On another hand, extension works for buildings and other infrastructures has an average duration of 2.1 weeks to complete the program of works. While the renovation projects have a slightly shorter duration than the extension projects with 1.9 weeks.

TABLE 8. AVERAGE DURATION FOR PROGRAM OF WORKS OF MINOR PROJECTS

Description	Average Duration (Days)
Embankment/Construction	7.2
Installation and Fabrication	4
Repair	3.7
Repair/Cleaning	3.7
Fabrication	3.5
Embankment	3
Installation	2.7
Repainting	2.2

The duration for working on the program of minor projects was determined with the unit of days. In table the combination of embankment works, and construction works has the highest duration with 7.2 days and it is being followed by the combination of installation and fabrication works with an average of 4 days. Repair, cleaning and fabrication works have medium duration with minimal differences. The minor project description with the lowest duration is the repainting works.

D. Interventions for Coping Up with Workforce Demand

a. SWOT Analysis

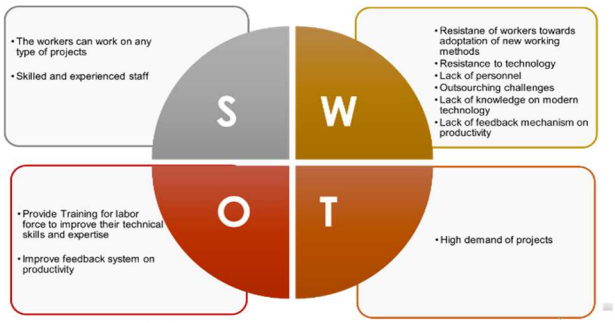

Fig. 6. SWOT Analysis

The SWOT analysis was used to see the strategic objectives for the first stage of the workforce planning. This led to the identification of the capabilities and gaps in the office and helped in aligning the strategies and future goals. The SWOT analysis is impartial and thorough in presenting both positive and negative aspects that affect the efficiency/productivity of the work force of the office of engineering in Cabuyao.

b. Program of Works Allocation System

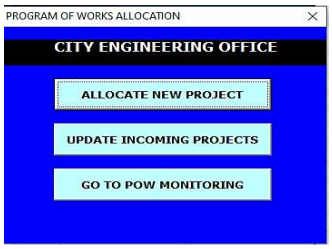

Fig. 7. Program of Works Allocation Model

The figure 7 presents the form that will be activated when the system has been opened. The button 'allocate new project' will be selected if a new request for project has been assigned to the office with no complications on budget requirements. The button 'update incoming projects' will lead the user to the Incoming Projects Worksheet if there are updates on the budgeting requirements of the projects that has been indicated as incoming which means, it will be allocated as the budget has been approved. The button 'go to pow monitoring' will lead the user to the POW Monitoring Worksheet to monitor the list of Program of Works and update by putting remarks, comments, and end date for the programs that has been completed.

Fig. 8. Allocate Buttons

The corresponding name of the button will relate to the action type that should be taken and will select the projects with an approved budget before taking the user into the project selection form. This category will help the user keep track of the urgency of a project and use it as a reference for decision-making for scheduling.

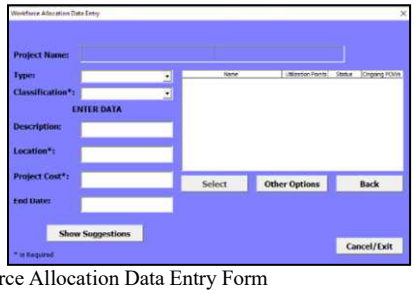

Fig. 9. Workforce Allocation Data Entry Form

The data entry form for workforce allocation where the user will be asked to enter the information for the new project that will be allocated to the personnel.

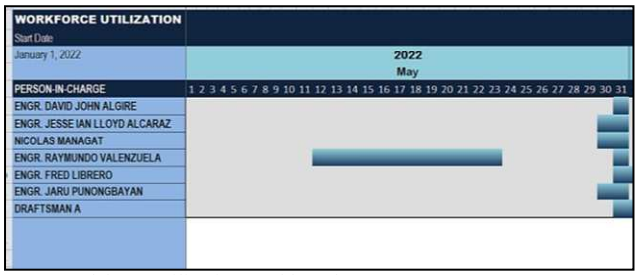

Fig. 10. Workforce Utilization Dashboard

The workforce utilization dashboard will generate a report on the schedule of working days for each project handed in to the person-in-charge. The data presented above are fictitious examples of project start and end dates in the month of May.

IV. CONCLUSION AND RECOMMENDATION

A. Conclusion

As a result, the City Engineering Office frequently faces the problem of an insufficient personnel resulting to pending projects and inability to accommodate new projects. In demand analysis performed in the year 2021, a fairly large number of construction projects was recorded. The researcher employed a ratio scale questionnaire to determine the duration periods for various types of construction activity, ranging from personnel to

personnel. Based on the results, the more complex a project is, the longer its work program will last. The intervention of an allocation system using Excel Visual Basic Applications is a technique that should be considered. The information gathered was used and processed to create the system, which considered workforce analysis, computation of utilization points based on budget and expected duration factors, and the current classified description of construction projects at the City Engineering Office.

B. Recommendation

1. The implementation of the task board in the City of Cabuyao Engineering Office will help by tracking details such as the person-in-charge, number of ongoing Program of Works and its details, current utilization and the pending projects. With these details, the organization will know how, when and why obstacles, if any, will arise along the way. Through these data, the organization will know how they will handle the future projects.
2. Providing training for new employees can give the opportunity to strengthen workers' skills, this will ensure that workers are up to par and can perform their job. Proper training and development can help identify weaknesses that can turn into strengths that can help workers excel and it is sure that every worker would be able to create a program of work and be flexible in any job that will be handed to them.
3. The City of Cabuyao Engineering Office's workforce may be double-scheduled; this is common when employees work two distinct sorts of tasks within the same organization. This is especially true for part-time employees who may have other obligations in addition to working for you. Full-time employees may demand additional or sufficient shifts to meet their financial commitments.

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