CHAPTER 5
CONCLUSION

Five models (four with monthly electricity data & one with daily electricity data) are innovated to predict the energy demand for commercial buildings in Colombo, Sri Lanka. The CVs, MSE and % error values for the final regression indicate the accuracy of the model to predict energy demand [27]. Moreover, lower MSE value will provide a good estimate of how the building will behave in the future and accordingly can suggest optimistic recommendations for improvements.

5.1 Achievements of research objectives

The objectives of the thesis are:

1) Analyze the existing methods for building energy consumption applied in the tropical region.

Mainly focused on comparing previous methodologies and studies used in building energy analysis based on baseline modeling. This also helped in creating a new successful method. Regression based model is considered to be more practical for all time periods' data, while neural networks and Fourier Series are more suitable for modeling hourly building cooling and heating energy consumption.

2) Explore and establish Support Vector Machine (SVM) in building energy consumption in tropical region.

SVM is found to be the most important methods which has been widely applied in different literature in forecasting and regression of random datasets. In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using kernel trick, implicitly mapping their inputs into high-dimensional feature spaces.

The results show that all the predictions for monthly load forecasting, CVs are less than 5% & for daily load forecasting nearly 8%. Low CV means, Qiong *et al*., [31], a good tracking ability along the monthly and daily bills, which is what building

owners want to know. This method is verified to have good prediction ability, and is sufficient to establish the baseline models for landlord energy consumption.

Moreover, when this is compared to monthly load forecasting in chapter 4, section 4.9; it proves that the short term load forecasting gives high performances with low MSE results than the monthly model. The reason for such prediction can be pointed out as the large daily data input to the model allowing it for high training facility to model rather than the monthly one. Further, the effect of environmental factors to daily load forecasting are much significant, Dong *et al*., [27], than the monthly period as in monthly load forecasting since it takes the mean value of all data as predictions inputs. Table 4.10 in chapter 4, shows the accuracy level of short term and medium term load forecasting results. Furthermore, for all five buildings the % errors are within 2%, which shows the accuracy of all five models, [27].

Furthermore, it is important to consider the seasonal variation & the fluctuation of the energy usage. The prediction needs to be carried out for high fluctuation of energy consumption in buildings rather than choosing small variation (section 3.7.1) of energy consumption in buildings. The main reason for that is, it cannot be model a system with high accuracy, if the energy consumption variation is a small value and if there is a seasonal pattern of the energy consumption the prediction will follow the pattern of energy consumption rather than predicting the future consumption.

5.2 Contributions of the study

1) A comprehensive review of the literature in the baseline model methods for topics with direction in future research.

2) A modeling method for building electricity consumption for commercial building in tropical region for both short term & medium term forecasting.

5.3 Recommendations for further research

The development of baseline model is very important. It is not limited to utility bill tracking or prediction although it is the easiest way to collect the data. The baseline model plays a significant role in the development of measurement & verification protocol. Hence, there are few recommendations for future research.

By examining the feasibility of more independent variables such as occupancy rate, extension of office area, it can be used to increase the performance of the model. Although most recent studies on the development of baseline models are focusing on the weather data variables, the variable such as occupancy and daily extension, also have impact on load prediction. However, modeling by using such input is difficult due to the difficulty of quantifying the relationship of these variables with electricity consumption. Moreover, than occupancy, there are other potential variables such as equipment operation hours and frequent increment of conditioned room area. A reliable and robust baseline model should include all-important factors that affect the building electrical consumption in order to improve the accuracy of the model. Therefore, future research should emphasize on performance driven by considering above facts to develop an improved electricity forecasting models.