Development that define the geometry of computational model.

Developmentof the generative model takes the first stage of process.

One of the mostimportant focus points of this stage is to develop a model as flexible as possible. In this context, the model is capable of adapting typical situations as anoffice building design with different shape such as rectangular shape, L-shape, U-shape and the T-shape, along with the different ratios of window wall (WWR)or fenestration ratio. In addition to this, developing a generative high-riseoffice model plays a key role in order to have same spaces and as well assub-spaces with identical areas throughout each shapes as design parametersthat define the geometry of computational model. On the basis of these findings, generative computationalmodel is reviewed in different steps that are expressed in the following part. Ifwe look at this issue from the fact of built environment, it is seen that thereare different types of high-rise buildings exist. In general, these types canbe mentioned as singular high-rises, twin high-rises or connected high-rises. In this study, singular high-rise buildings were selected as a focus point thatwas already mentioned in the first chapter.

So as considering singularhigh-rise office building, four different shape is developed like simplerectangular shape, L-shape, U-shape and rectangular with inner courtyard asshown in figure 3. 3. Eachshape have been considered as same spaces and areas for comparative analysisfor its multi performance integrated design as results. Orientationof building is the most important and curial feature of the high-rise building. An appropriately orientated buildingcan save a lot of money in no longer required heating and cooling costsspending. But sometimes, orientation of building awarded fixed due to the roadexcess. Same case have been consider in this research as the

building facestowards south as shown in Figure 3. 3 because of having main excess to the site.

And as we fully aware that the south part of the building have faces most ofsun light to the maximum time periods. The area of this particular site iscalled central business district (CBD) and have mostly high-rises buildingaround which either faces towards south or north direction. Relativecompactness is used in this study as a sign of building shape to help theproportional analysis when assessing the impact of shape and geometricdimension on the building energy performance. It is termed mathematically asfollow: RC = (V/AS) building
(1)(V/As)Ref Where (V/AS) building is thecompactness of a precise shape, and (V/As)Ref is the compactness of the reference building (which has a rectangularfloor plan). Note that V and As refer, respectively, to the conditioned volumeand envelope surface area exposed to the outdoor area (exterior wall area). Asindicated by Eq.

(1). The relative compactness (RC) has no dimensions. Since thefloor area and total height of any building are constant, the building volumeis constant for all the buildings.

So, Eq. (1) can become as: RC = (As)Ref / (As)building
(2) Table3. 2 shows the geometric features for various building shaped used in the study.

These geometric characteristics include: the dimension of the boundingrectangle, W and D, the perimeter (P) and the relative compactness (RC). Aninteresting observation from table is that the perimeter values of the

L and Tshaped buildings are identical for the similar bounding rectangle dimension (Wand D). Another thing, the values shown in Table indicate that higher RC isassociated with lower perimeter. Window to wall ratio (WWR)is a most major component which affecting energy performance in a building.

Onheating, cooling and lighting window area have impacts on the building as wellas relating it to the natural environment in terms of access to daylight and ventilation. The window-to-wall ratio is the percentagearea between building`s total glazed area and exterior envelope wall area. Theanalysis in this study is carried out for different window sizes and glazingtype.

In specific case, considered all four shapes was been set window to wallratio to vary from 0. 01% (openings) to 0. 99%. For clear understanding of windowwall ratio figure 3. 4 below is mentioned.

Modelsfor office building with several shapes have been established by usingRhino-Grasshopper. For all models, typical office space pattern and schedulesmeet for Karachi condition used. Several constraints are varied to assessmentthe energy performance with different buildings shapes and relativecompactness. The analysis also considered various window ratio and glazingtypes. In particular, window to wall ratio was set to 0.

01% to 0. 99%. Variousglazing types with different solar heat gain coefficient were analyzed. Table 3. 3, summarizes the glazing types by its SHGC and window to wall ratio.

Inthe scope of generative principles of model mentioned in the previous part, thissection focuses on evaluation of that model within the framework ofmulti-

performance criteria, which have also an important place for tallbuildings. It is obvious that buildings are under the influence of manycriteria that have an impact on their performances as well. Regarding to reachbetter buildings, which also mean better performances, performativearchitecture notion has come up. Kolarevic (2013) states the performativearchitecture as, performative architecture can be defined as the one in whichbuilding performance, broadly understood, becomes a guiding design principle.

In other words, it can be said that the role of architect is tomulti-performance criteria into design process. Hensel (2013) points out theimportance of this multi-performance continues as, architecture is urgently inneed of integrative approaches that begin to combine specialist discourses forthe sake of encouraging determined efforts towards improving the builtenvironment and its weakening impact on the natural environment. According tothese accepted senses, it is possible to say that integrating performanceaspects have a remarkable role in the process for all building types. Thisintegration should be started at the earliest design stage, which is called as conceptualphase and also kept on further progresses.

The further steps in the context of specializationand continue as, Architects should be in collaboration with professionals fromother disciplines in order to criteria that they focus, require aspecialization. Based on this theory, it can be said that, collaboration among professionalsbrings more realistic alternatives. Inaccordance with these arguments, the generative model was evaluated by seriesof performance criteria, which have a remarkable role in terms of sustainableand economical aspects in this research. In this regard, performance criteria have been integrated and evaluatedin Onthe basis of

previous statements, this part focuses on reaching sustainable buildingat the initial design process, which is also called as conceptual phase. Yeang(2007) expresses the reason why high-rise buildings are un-ecological andcontinues as, Its un-Eco logicalness is of course largely due to its tallnesswhich requires for instance larger material content in its system to bear the higherbending moments caused by the forces of the high speeds at the top reaches ofits built form, greater energy demands to transport and push materials andservices up the building’s floors working against gravity, additional energy consumptionfor the mechanized movement of people up and down its elevators, and other enhancedaspects arising from its excessive verticality.

Within this context, it can besaid that high-rise buildings have no enough capability to become 100% sustainablebuildings. However, there are some criteria which have a remarkable role in theprotection of nature may be applied to protect the built environment. Usingless artificial light, smaller footprint, gaining solar energy, using windenergy or wasting less energy for heating and cooling are shown as basicsustainable factors in high-rise designs. In this respect, evaluations ofdaylight factor and solar radiation are defined in the developed model.

Energy has a major role in improvement ofenvironmental quality relate to overall building efficiency evaluation systemand has also bi impact to reduction of cost. Energy consumption of the buildingdepends on working hours and duration of occupants. In this reference, Bairdand Donn (2006) explained, it is the best allowed distribution of energy useper unit area by a

factor that is constructed on the basis of activity in thebuilding or around working hours.

Being considering the most relevantcharacteristics in a building it is also decisive for its energy consumption. In the direction of the statements, energyperformance of developed office building model is evaluated in SefairaArchitecture component in SketchUp program. This component includes allcalculations about how to calculate heating and cooling as energy loads. Asthis component is integrated to SketchUp program, evaluation of the model isupdated in real-time.

As can be seen in figure 3. 7 the method of evaluation isillustrated. In the first step, surfaces is createdaccording to the specific spaces and sub-spaces areas of the building plan thatare considered as useable boundary. By doing this, materials of surfaces werealso defined within the context of material library depending upon floor types, glass type façade. It is important to express that materials have an influenceon the calculation of energy consumption because of different materialproperties. As a second step, the weather data file ofactual region was added depending on location of evaluated building. At thisstage, it can be helped from the web site of EnergyPlus™(https://energyplus.

net) which is a whole building energy simulation programthat engineers, architects, and researchers use to model both energyconsumption for heating, cooling, lighting loads use in buildings. As a final step, after assigned all basisnecessary components like spaces, floor height, openings and type of glazing, simulation is run and collect result of energy analysis. In

this manner, theseall factor count has an effect on solutions in order to reach detail results. These factors has given the related result which is need for the finalconclusion. However, assessment of energy may require theselection of specific hours, days and months in order to run the module. In thecontext of this study, annual (yearly) evaluation was applied for evaluation ofenergy performance for an office buildingForthe current research, a performance base parametric model was generated forexploring the alternatives in the design for office building and the responsevariables of the has been set for each of the shape in Microsoft Excel byrandomized values of window to wall ratio (WWR) and glazing types along withthe relative compactness (RC), which already calculated above.

For all fourRectangular, L, T and U shape building, these classified under the Table 3. 4, Table 3. 5, Table 3. 6 and Table 3. 7.

The established parametric model has threeindependent variables, and only one response variables that are performance. The next step was automating the process of recording random independentvariables performance for the each building shape with its geometric dimension.