Models for Architecture of Contemporary Medium-Density Mixed-Use Buildings - Case Studies from Gliwice, Poland

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Abstract. Mixed-use buildings are objects of more than one use. The structure of a typical mixed-use building allows for access of at least two groups of users: both groups take advantage of the presence of the other one. Advocates of the compact city policy argue that mixed-use buildings are necessary for reaching compactness. The demand for density in developing cities is growing since the prices of land are rising and there are nearly no vacant plots in the centres. Most of the low and medium-density implementations do not use a mix of uses since it complicates the building structure. Although there are no universal measures for low, medium and high density, the author believes that can relate to the location and site characteristics. Asian ultra-high densities are generated by different conditions and local background and cannot be compared to the European examples. Also, the terms low, medium and high density have different meanings and values in small, medium and big cities. This article presents 3 case studies of designs for 2 mixed-use buildings in the medium-size city of Gliwice. The case studies illustrate the local determinants set in the local development plans that limit the development by setting the minimum and maximum values of urban indicators. The authors conclude that, sometimes, planning regulations result in very extreme values of the urban factors that must be met by the new development. However, those are not the only answers sometimes. Planning does not always foresee or meet the needs of the changing urban environment and society. Observation of the executed process of implementation shows that hypothesis may be right.

1. Introduction - mix of use and medium-sized cities
The concept of mixed-use has been implemented since ancient times, if we consider that craft workshops were located in the same building as the space for living. For ages, buildings were growing and could fit more: they were taller with more floors and became more compact, to have more uses. The term vertical urbanism has emerged recently and refers to high-rise multifunctional complexes. Jane Jacobs, writing in the 1960s, argued that the city, with its vitality, mix of uses and tradition, represents the most desirable form of development for people whilst also encouraging wealth creation and innovation [1]. According to Grant [2], the concept of mixed-use has become “a mantra in contemporary planning”. The term mixed-use appears dozens of times in research papers and books on compact cities. The good example can be the ‘bible of compact city’ idea. The Compact City: A Sustainable Urban Form? edited by Mike Jenks, Katie Williams and Elizabeth Burton: It says the compact city is most likely to be brought about by intensifying existing urban areas -increasing densities, activity and the mix of uses - and by attracting people back into the city [3]. Some researchers call mixed-use buildings hybrids, and as Fernández Per et al. stated, the history of hybrids begins at the end of the 19th century, when the dense city started to accept the overlapping of functions as inevitable [4].
This paper examines medium-density mixed-use models even though there are no definitions of low, medium or high density. Some researchers argue that those can be described by particular values of indices such as: plot coverage ratio (PCR), dwelling per hectare (DPH) index, floor attenuation ratio [FAR] or population per hectare index. The density atlas published online [5] and maintained by MIT researches, identifies low/medium/high density by all of the indices in 3 different scales: block, neighbourhood and region [6].

Usually, it is hard to measure FAR and DPH in larger scales, such as the regional scale. Planning policy makers in Europe identify housing ranges for densities by population density or DPH index. However, there are very few research papers on commercial use density that identify low, medium and high density. The author believes that there is very little evidence and research on indices regarding non-residential use. We can assume that usually this is either a percentage of the total area of the building, or a percentage of FAR ratio or amount of separated commercial uses (in order to get several small uses instead of one big, for example to get a few small shops instead of one). Usually, the decision-makers are the planners who make decision on the basis of their own experience and construction law.

In general, low densities are identified in large urban areas with single-family houses, semi-detached houses and low multifamily houses on large plots with 0-40 dwellings per hectare of housing density. Medium densities are commonly recognized as densities ranging from 40 to 80 DPA with dense terraced houses, terraced houses and low multifamily houses on smaller plots. Very often the medium level can be described by the number of floors not higher than 4. Very often, Local Development plans limit the density by FAR or number of floors locally, depending on the context and neighbourhood.

Professional research on mixed-use land use patterns has been recently (2011) conducted by Berhauer Pont and Mashhoodi [4]. They define mixed-use as functional mixed-use and they are interested in understanding the spatial conditions needed to increase the diversity of uses (mix) by combining compatible functions. In their research on mixed-use, they argue that that mixed-use blocks have greater areal density than mono-functional blocks [4].

The mixed-use concept also has an impact on commuting. Many researchers try to investigate the relationship between travel distance and density. Some show the relationship between the density and travel mod. The findings presented by Frank and Pivo state that the relationship between mode choice and land-use mix can be measured at the census tract scale; however, the relationships are relatively weak, [10]. Others argue that there is correlation between density and travel distance [Barret in 3].

Some researchers try to investigate the relationship between mixed-use buildings and energy consumption. Young-Eun Woo Gi-Hyoug Cho showed a study on mixed-use buildings in Seoul with non-residential and residential uses. As they state, mixed-use development is understood as crucial to achieving a “compact city” and a viable urban environment in the urban planning field but the relationship between mixed-use buildings and energy consumption is rarely known, [3].

Some researchers try to investigate the relationship between compact forms and social sustainability outcomes. Bramley Powers presented research findings that led to conclusion that compact forms worsen neighbourhood problems and dissatisfaction, while improving access to services [2], while others claim that better access to services and transport in compact neighbourhoods is an advantage.

The higher density we get the more mixed-use we can get. The highest densities in the world are also becoming more complex and mixed. Some evidence has been presented by Generalova, Generalov, Kuznetsova, Bobkova in an overview of the tallest mixed-use buildings in the world. Generalova et. al. state the typology of mixed-use tall buildings is being actively developing. This development is a immediate search in modern interpretation of the concept of the vertical city, where people can live, work and relax [9]. The idea of models for mixes of uses in different densities has been presented on the Figure 1. The concept of models which represents the optimal solution seems to be obvious and understandable (see Figure 1), but mixes of the uses may be very dependent on the local situation.
2. Gliwice - location background and case studies

Gliwice is a middle-sized city with ca. 180,000 inhabitants, located in southern Poland in the Silesian Metropolitan Area, a large industrial region which slowly starts to shift from industrial use to service use. Gliwice is a city in transition: urban regeneration is being processed on post-industrial sites, new sites are being developed either for housing or modern industry. The last vacant plots in the city centre are being developed, also revitalisation investments are realized: mostly for commercial and housing uses. Also, the process of winning the public space for pedestrians has started recently: more and more new streets have been either pedestrianized or the traffic is being slowed down by new investments. The first woonerf in the Silesian Metropolitan Area is currently (2018) being implemented on Wieczorka street in Gliwice.

The urban fabric of Gliwice is typical for a contemporary city of historical Medieval origin: its density starts at a very high level in the city centre, decreases to medium in the midtown, and falls to low on the outskirts (see Figure 1). The City Development Plan of Gliwice identifies 3 types of housing density: high, medium and low [11]. In the document, the definitions are not stated clearly, but very often they result in following regulations in the Local Development Plan: high density is defined as a building of medium height (more than 4 stories by Polish regulations), FAR of more than 1.5, medium density is defined as maximum height of 4 floors and FAR of between 0.5 and 1.5, and low density areas are planned for buildings with no more than 2 or 3 floors and FAR of no more that 1 with maximum of 0.5 PCR (see Fig. 2)

2.1. Kozielska 6 case study

The Kozielska street is an important link between the Gliwice city center and the western part of that city. The site located at Kozielska 6 is very well connected - only 1000 meters away from the market square (of Medieval origin), see Fig. 3.
Figure 3. Kozielska 6 location and close neighbourhood; [12]

The plot at Kozielska 6 covers 931 sqm and was vacant for years. In 1990s, there was a temporary pavilion which served as a shop and a fruit market located on the front of Kozielska street. Until 2014, the back part of the plot was undeveloped and covered with bushes, trees, rubbish. In 2012, the City Hall of Gliwice decided to sell the plot publicly. The local development plan (official law in Gliwice established by President of the city of Gliwice) allowed for the plot coverage ratio 0.7, Floor attenuation ratio minimum 1.0, minimum 50% of the total building area was meant to be for commercial use [13].

Figure 4. Kozielska case study: architectural model and mixed-use model: commercial use (grey) and residential use on the plot; T. Bradecki

The design covered 70% of the plot, with the total area of the building of 1,057.32 m2. Basic use - commercial – 573.28 m2 (54%); additional use: apartments – 484.04 m2 (46%) - the design included the following obligatory index: car parking space per apartment: 8 m2 for commercial use customers (4 car parking places per 100 m2 ratio), one parking place for employees (ratio of 15-25 car parking places per 100 employees) and 2 car parking places for inhabitants (1 car parking place per apartment) - sum of 11 car parking places. The basic reason for such a minimum FAR is the required Car parking ratio: the longitudinal length of the plot was too small to design effective underground car parking.

The design process lead designers to alternative scenarios with even higher density. Figure 5 shows the density of 2.0 with 3 stories. However, the limit of car parking ratio turned out to be impossible to realize. The plot was too small for designing an underground car parking.
The initial design assumed: 2 apartments on the second and third floors, commercial space for a pharmacy, a store on the first floor. Terraces located on the roofs constituted additional space that added value to the estate. The Park around the hospital located just next to the building provides good neighbourhood and greenery which is not that common in such a dense urban landscape.

The architectural design for Kozielska 6 was in minimal contemporary style. Large glazing was designed from the front and from the courtyard, as well as visual information for the planned commercial uses. A staircase has been designed with an entrance from courtyard. The staircase provides access to the apartments above the first floor. Three different commercial places occupy the first floor: a pharmacy located in the front of the building, a store in the back and also a small post office between them. The whole second floor with terraces is being used as dance school (dance academy). Very soon after construction of the building, it turned out that the apartments on the top floor have been rented and used for commercial purposes, also car parking places have been rented and are not being used for parking cars. Therefore, only 4 car parking places service the building.

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**2.2. Floriańska case study**

The Floriańska clinic house case study is an exceptional example of an attempt to merge two different functions: a single-family house with commercial space that serves as the clinic. The plot covers 843 m2 and is located in the midtown – not so far from the city center, in a residential quarter. The Floriańska
street has regular, calm, residential traffic and provides access to the plot. Some commercial uses (stores, school, church) are located in the very close neighbourhood. Single-family housing is located next to the plot and multi-family housing – on the opposite side of the Floriańska street (see Figure 7). The plot has a close connection to public transport - ca.400 meters from the Toszecka street.

The initial idea was to design a two-story building with a clinic on the first floor and an apartment on the floor above. Since the investor demanded the entrance hall that is 2stories high, the entire concept became more complicated. Polish regulations state that a single-family house with commercial use can be designed in the proportion of 33% for commercial and 66% for residential purposes. This fact complicated the design even more: an additional story has been designed on the top, just to meet that regulation. That also impacted the density: with 3 stories the FAR ratio reached 0.6 (with 0.8 limit under the LDF [14]). The building has been located with minimal offset to the plot borders and so the PCR was 0.3 and was at a maximum value. The green area ratio with the value of 31% was very close to the minimum (30% set by the LDF regulations).

The car parking issues were not that complicated as in the first case study, but still the local development plan required at least 4 car parking places for the investment. Those have been provided in front of the building. We can assume that these will be enough because of public transport proximity. The architecture of the building is mainly driven by its function. The staircase with a separate entrance has been located on the opposite corner to the entrance for clients. The apartment has been slightly
emphasized in its form – its grey body overhangs the front of the building. The top floor is a glazed pavilion with terraces on the roof (see Fig. 9).

Figure 9. Floriańska case study: aerial view of the neighbourhood (source: maps.google.com) and street view (T. Bradecki)

3. Results and discussions
The results from case studies analysis and observation can be as follows. The Kozielska 6 case study shows that nearly 24-hour life can be provided only by one use, commercial use: a dance studio which is located on the top floor: it works mostly in the afternoons. This example is exceptional, but the residential use which brings life in the afternoon and evening is definitely not the only one.

Kozielska 6 shows that sustainability issues can be brought to the city center. The solar cells that have been mounted on the rooftop can cover up to 70% of the building’s demand for electricity during summer. According to the author’s knowledge, it is one of the very few buildings (or the only one) that use such sustainable solutions in the Gliwice city center. The car parking ratio set in the Local Development Plan required more car parking places than are actually being used: (requires 11 according to the mixed-use scheme and nearly 20 for the full commercial scheme).

The clinic house case study showed that a design of a single-family house with a big commercial programme results in a complicated functional layout but can be delivered in that form. The car parking places ratio also was problematic in that case, since the distance between the commercial use and the car parking cannot be 0, and must be at least 4 meters from the building’s window, according to building regulations. The clinic house has not been constructed yet, but it may be presumed as a good illustration of reaching high density value in the medium-density category. The floor layout allows for further potential conversion from mixed use to single use: either residential or commercial.

Both concepts show that very high density can be achieved but despite the location in the city center, car parking has to be provided in general. Both plots were relatively small and that limited the design. Brief results have been showed in table 1.

Table 1. Case studies comparison

| Case study      | PCR | FAR | DPH | No. floors | No. of car of parking | Plot area | Total m² |
|-----------------|-----|-----|-----|------------|-----------------------|-----------|----------|
| Kozielska 6     | 0.7 | 1.1 | 2   | 2          | 11                    | 931       | 1057     |
| Kozielska 6     | 0.7 | 2.0 | 4   | 3          | 14                    | 931       | 1810     |
| Florianska      | 0.3 | 0.6 | 1   | 3          | 4                     | 843       | 529      |
4. Conclusions
This paper presents findings from the research conducted to test the presence and the relationship between mixed-use idea urban principles and mixed-used architecture. The main conclusions of the study on medium-density mixed-use developments can be as follows. Local development plans cannot forecast the real need and use: sometimes the real estate market, local conditions and the so called 'life' or users' preferences prove that the local demand is slightly different to the regulations. The indices set in the plans might not be correct: especially the car parking ratio. City centres are serviced by public transport and can be used by pedestrians (customers), and so fewer car parking places can be delivered. This conclusion meets the current trends in urban design to minimise the traffic and win more pedestrian-friendly public space. The author suggests that the only answer for the car parking ratio is: the car parking ratio should be public transport-dependent, and the rational solutions that can help to reduce vehicle traffic, should be promoted.

There are also some findings for the architectural design process. Mixing the uses must result in mixing the users at some point, while they use the building or the area. The conclusion may be similar to the authors' research into low-density mixed-use buildings: It is very hard to find a proper compromise solution for both uses and not to create conflict among users [6, 15, 16]. However, it is more obvious and understandable for users in higher densities since the buildings in the medium and high densities are larger in volume.

Medium-density buildings very often must be constructed on small plots, which make the design solutions complicated. The mixed-use models for the case studies have been presented in Figures 4, 5, 7 and somehow refer to the assumption models presented in Figure 1. Still, such model approach depends to a high degree on the architecture and the location. It may be considered that no optimal model can be applied anywhere, but it will always be subject to individual approach. The findings summarized in this article may be useful for architects, urban designers, urban planners, urban policy decision makers.

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