International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 15 (2017) pp. 4946-4954

The Influence of Building Typology on the Economic Feasibility of Urban Developments

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Abstract

The decade leading up to the economic crisis of 2008 was characterized by a massive expansion of the property market, in terms of both market values and investments in urban developments, promoted largely by means of a densification of urban areas. The constantly rising value of certain areas, especially in the cities, made it preferable and economically worthwhile to reconvert brownfields, increasing their buildable volumes in the process. The slump in investments nowadays is attributed entirely to a period of prolonged economic stagnation, but in fact the feasibility of high-density property developments has specificities that have yet to be thoroughly investigated, and that sometimes have nothing to do with the current frailty of the market.

Densification processes are characterized by building typologies associated with construction costs that profoundly influence the economic sustainability of a given project. This article proposes to examine this relationship between building typology and construction cost, presenting the findings of a preliminary empirical investigation conducted on six cases, three in Italy and three elsewhere: the former three cases concern developments that underwent radical changes to the original plans in order to keep them economically sustainable; the latter three projects were implemented as planned, but their production costs have proved unsustainable for the purposes of providing a return on the investments.

Keywords: Urban density, Real Estate, Economic Crisis, Economic feasibility, Planning.

INTRODUCTION

In terms of their *ex ante* economic assessment, the sustainability of construction projects is based primarily on their economic and town planning components: their design features are of marginal relevance, and only considered in terms of the property development's esthetic appeal, or other features functional to its subsequent marketing.

Choices made at the design stage shape a city because they are the outcome of theoretical and methodological architectural considerations, but they are also the material response to essential economic requirements that decide a development's feasibility, and to the demand of the property market.

Since the mid-1990s, there has been a convergence between the interests of town planners and real estate developers: considerations on how urban sprawl has changed the territory are relevant to the design of a city [1, 2, 3], as well as to the urban economy, and property evaluation [4, 5, 6]. The change of heart that led to the sprawl being abandoned has taken shape in the paradigm that strives to reduce land taking for environmental reasons and to improve the landscape, and to achieve the goal of restoring whole areas of the city no longer in use as a result of industrial reconversion processes prompted by globalization.

These were times of radical change in the Italian property market, which experienced a phase of enormous expansion. Constantly increasing market values and the strong pressure of the demand in central and semi-central areas of the country's towns and cities generated a new development of the market, partly thanks to the influx of capital from international finance. This process was sustained by the local administrations, thanks to the innovation of the planning tools for implementing development projects. New, experimental models of public-private partnership that emerged during those years are now established practice in most of the country. The public sector's involvement in such an approach fulfilled two main goals: (i) to requalify brownfields without spending public money; and (ii) and to induce private operators to finance public services and buildings as a way to recover and redistribute the capital gains deriving from changes to the zoning laws [7].

So, while there was an alignment between the goals of town planners, property values, and real estate investors, the design aspects of any requalification schemes were considered mainly in terms of their iconic value. The assessments of the economic feasibility of the urban development projects mainly considered the densification processes from a merely quantitative standpoint, while they underestimated the

importance of the construction costs (and more in general of the production costs) in relation to the specificity of the projects based on this new urban paradigm [8].

The high market values of real estate seemed to sustain ambitious and innovative development projects despite the ever-increasing unit costs of their construction. But while the production cost component was underestimated, its incidence in terms of how the overall cost of complex buildings was to be managed was completely disregarded. The effects of this failure to jointly assess the design and the economic and financial aspects of a project have become amply clear since the global financial crisis of 2008 [9].

The slump in demand due to the credit crunch, and the drastic drop in property values have affected all sectors of the real estate market. But the wound inflicted by the economic crisis on the face of the cities takes material, physical shape in the building sites where work has been suspended, and the big empty sites of the densification projects never even begun. Where considerable volumes are involved, the echo of the market's shrinkage reverberates powerfully on two fronts, i.e. the implementation of the large-scale urban transformation projects, and the management of major assets already completed. Both types of problem stem from the difficulty of controlling the production costs on the one hand, and the overall cost of complex building typologies on the other. The former situation is particularly widespread in southern European countries, where the sovereign debt crisis gave rise to a more severe recession. The latter is more often seen in countries characterized by a more dynamic and volatile real estate market, such as Great Britain and the states of the Far East[1].

This article aims to show that, for numerous projects, the present critical situation is not only due to the slump in the economy, and in the real estate market in particular. It is also the result of an underestimation of the specific cost components of a project, to which too little attention had been paid even during the real estate market boom.

In assessing the economic sustainability of real estate developments, the core importance of production costs deserves to be analyzed in more depth, particularly in relation to the typical building typologies of densification: the tower and the skyscraper.

The technical problems associated with the construction of tall buildings were overcome more than a century ago, but their economic issues are complex and variegated. The uncertainty surrounding our ability to foresee the trend of the costs during a project's development and the subsequent useful life of the resulting building comes to bear on the related multifaceted risk component, which pools together factors relating to both the production and the marketing of the property [10].

An increase in the marginal construction costs is characteristic of the tower and skyscraper typologies. Probably even more important, however, is the variability of these costs in relation to the design solutions adopted: an efficient geometry can be fundamental to the economic feasibility of a tall building.

To ascertain the real relevance of the production costs and overall costs of tall buildings, a survey was conducted on several important investments in urban redevelopments in Italy. Our first findings showed that the reconversion of major areas in some cities was completed (albeit after long periods when the works were suspended) thanks to a radical revision of the design solutions adopted, i.e. of the originally planned building typologies. The link between the incidence of the production costs and the building typology is demonstrated by the fact that the revised projects achieved the same densification (or buildable volumes), it was only the building typology that changed substantially.

We describe six cases identified in Italy and abroad that illustrate this situation. The first three cases concern projects originally conceived as having a tower typology but, after being put on hold, they were subsequently completed (achieving the same built volumes) after changing their design to a block typology. The reasons for doing so seem to lie in the importance of the production costs, and the different incidence of these costs on the different building typologies. The second three cases concern projects that were completed abroad, but with construction costs that ultimately proved unsustainable - even in very dynamic property markets, and despite the buildings' producing significant revenues.

In the light of these considerations, the study proposes a reflection on the incidence of the production and management costs as a crucial component for the efficient promotion of urban requalification and regeneration projects in high-density settings. In particular, we focus on how the choice of building typology is fundamental to the success of a proposed conversion.

The article is arranged in five parts: the first presents a critical review of the literature on the topic; the second further analyses the correlation between construction costs and vertical development; the third describes the case studies examined in Italy; and the fourth reports on cases of skyscrapers built in the United States and the United Kingdom; the fifth and final section contains the conclusions and some lines of research to consider.

THE RATIONALE BEHIND TALL BUILDINGS

The origin of the skyscraper and its fortune as a symbol of the modern city of the 20th century have been the object of an abundance of scientific and other literature, particularly in North America. The economic interpretation for its success

[1] Although much the same might be said of the United States, their property market has specificities relating to the residential segment and linked to the crash of the credit system that go beyond the scope of this paper.

had emerged already in the first half of the 20th century: tall buildings were the economically most rational way to use the available land in places where the value of the land was high, the demographic pressure (as a proxy of the demand for property) was high, and there was a high concentration of businesses and economic activities. As Clark and Kingston neatly put it: "*Given the high land values in central business sections of our leading cities, the skyscraper is not only the most efficient, but the most economic utilization of certain strategic plots*" [11; 12].

From the land economics perspective, densification is the outcome of the preferences of families and firms to live and work in cities that give them access to good infrastructure and the opportunity to make the best use of their resources [13]. As Hensley and Strange said: "*skyscrapers are seen as manifestations of the fundamental tradeoffs of land economics, with differentials in access locations determining land price differentials, which in turn determine building heights*" [12]. The concentration of economic and social capital in a given area thus triggers an increase in the prices of property (buildable land or buildings) such that vertically exploiting the area's building capacity becomes the most efficient way to obtain returns on investment capital, given its high baseline value.

More recent urban studies have revisited this paradigm, suggesting different, partially contrasting explanations for the phenomenology of the skyscraper. One is an extension of the classic idea of a rational use of land and building capacity, but sees the high values of buildable areas as being at least partly due to market distortions produced by *zoning*. This phenomenon, which is readily summarized in the term *zoning tax* [14], relates to the influence of town planning regulations on property prices, especially in North American cities [15] and on housing generally [14]. The local zoning law has certainly been important in shaping the city and, from a merely economic standpoint, it can influence production costs, and market prices and values as a result. From the point of view of our study, however, the norms that define and restrict land use, and the allowable mixed uses, cannot help to explain the success of some design solutions, and especially of some building typologies rather than others, given the same restrictions on buildability and usage. Zoning laws certainly contribute to price formation, but – *ceteris paribus* – they do not appear to be a decisive factor in the sustainability of an urban reconversion project.

Another interpretation makes a fascinating counter-intuitive claim that takes a new perspective on the topic considered here. Based on a historical series developed using descriptive statistics concerning the tallest buildings constructed in the 20th and 21st centuries, it was demonstrated that the building of skyscrapers (especially the tallest, the record-breakers built during the reference period) frequently proved ruinous from the point of view of the real estate investment [12, 16]. Such a skyscraper's limited ability to assure an economic return did not limit its diffusion, however. This is because the added value (also in economic terms) of the *tallest building of all* is of strategic value as a status symbol [16]. Demonstrating the capacity to build a complex, imposing structure produces a return that goes beyond the economic profitability of the investment, and has a far greater echo in commercial terms [17]. This is the case, for instance, of the Chrysler Building or the Petronas Towers. Certainly, neither of these real estate developments were profitable, but they amplified the value of the Chrysler company in the former case, and of the city of Kuala Lumpur in the latter. The aim here was therefore not just to make a profitable investment, but to provide durable proof of a capacity for expenditure, and of global relations and a vision that puts the competitors in the shade. In economic terms, the competition to construct the tallest building offers "*extensive evidence that builders attach value to having the tallest structure in a given market*" [12]. The previously-mentioned Chrysler Building, which is taller than the Bank of Manhattan Building, is part of a broader competition between Chrysler and General Motors. The immaterial benefits of being able to construct *the tallest building* as a way to advertise and consolidate a company's trade name have a corresponding value in territorial marketing terms.

In many cases, the choices made by certain companies, supported by the local administrations, have generated the so-called "*Bilbao effect*" [17] i.e. the identification in the collective imagination of a given metropolitan system with its most representative building. The Guggenheim Museum in Bilbao places at the heart of the international tourist routes (in Europe, at least) a little-known city in economic recession. Bilbao was in search of a new identity after the decline of the industrial fabric on which its economy had previously relied. The investment of a global player in the world of culture generates positive externalities for the city that go well beyond the capacity of the Museum alone to provide a return on the investment required. There are plenty of other examples of this phenomenon, from the Opera House in Sydney [18] to the hugely famous Empire State Building (which had already been nicknamed the *Empty Building* within a few years of its completion). The contrast between the ruinous outcome of the real estate investment for the construction of this skyscraper and the incommensurably positive fallout for the New York economy (the building soon became a symbol of the city in books and films, and it is still a compulsory stop for tourists from all over the world flows) is proof in itself of the economic value attributed by companies the world over to *the tallest building*.

The height issue as a crucial factor for the economic sustainability of investments has been the object of more recent studies on skyscrapers [16, 19], or the so-called *super*

tall towers[2] (STT) [17]. It is common knowledge that, from an economic standpoint, it is worth building higher and higher for as long as the marginal costs of adding another floor coincide with the marginal revenues. But it is the high volatility of the marginal costs of construction with the increasing height of the building that is investigated. In the main, the findings of statistical analyses have varied considerably in the approach to identifying an optimal height in the economic sense [20], but also in terms of how the cost function is studied. The most dated analyses modelled a linear trend, with the unit costs rising the higher the building [21]. More recent studies, on the other hand, have produced rather equivocal results concerning the real trend of the cost function with increasing volumes and heights of buildings [22].

THE ECONOMIC FEASIBILITY OF URBAN DENSIFICATION

In terms of building typology, urban densification can take two main forms: towers and blocks. These typologies differ in economic terms because of the different incidence of the three main components considered when assessing the feasibility of a property development: revenues (including selling prices or market values), production costs, and the risks related to the conversion project.

For the same density and functions, towers can be expected to offer higher marginal revenues than blocks, for two main reasons, one relating to the intrinsic characteristics of the typology, while the other has to do with the nature of the investments.

Towers and skyscrapers belong to the luxury segment, whatever their intended usage [17]. With the exception of the historicized phase of the post-war years, when residential towers were the solution adopted in Europe and the United States to deal with an urgent demand for social housing, the skyscraper had always been a niche investment. Even today it is more common in areas with a high rate of growth and capital investments such as China, Southeast Asia, and the Gulf States. From the perspective of rational developers, therefore, choosing a tower typology offers better returns. But the greater profits they can expect are not only because these buildings are part of the higher segment of the market for finished goods, but also because they are needed to balance the greater risks associated with such investments for the real estate developer. The risk associated with investments in the tower typology have two main particular features: the time it takes to complete the construction work; and the need to finish the whole building before the property can be placed on the market; there is no way to defer parts of the development. The cycle that begins with the promotion of the project, goes through the conception and design phases, the administrative procedures needed to obtain building permits, and the actual construction work takes at least 10 years. Meanwhile, this demands a massive commitment of financial resources on the part of the investor, and a significant and prolonged financial exposure. Such a lengthy timeframe amplifies the ordinary risks intrinsically associated with investments in property development. The economic feasibility of an investment is assessed at the initial design stage and the duration of the works exposes any real estate project to the risk of the real estate market entering a different, less favorable period between the phase of prediction of the revenues and the actual marketing of the property. As Lessard and Miller [10] put it: "*The ability to forecast demand varies widely, thus creating high levels of risks*". The risk is very real: the global financial crisis that began in 2008 and persists in many European states under the burden of their sovereign debt has led to a huge number of investments being aborted in Italy too because of the discrepancy between the market predictions and the new economic trends.

This phenomenon tends to repeat itself. In 1999 Andrew Lawrence completed his *Skyscraper Index*, and showed that the completion of the tallest buildings in a given period predicted the imminent conclusion of a positive real estate cycle and the start of an economic-financial slump [23, 24, 25]. The historical series analyzed by Lawrence show a correlation between the announcement of a project to construct the *tallest building* to date in a phase of growth in property prices and demand, and the building's completion not long before one of the most far-reaching and significant global financial crashes.

Although this theory is questionable (and there are several excellent cases that disprove it), the idea nonetheless helps to underscore the risk factors coming to bear on property investments of such complexity, and how the gains expected at the baseline can rapidly dissolve, irreversibly condemning the development project to failure.

The market risk is one of the main factors differentiating between tower and block typologies. Unlike the former, the latter allow for investments to be diversified and adjusted. The project can be implemented in stages, flexibly adapting it to market demand over time, and even changing the quantity of building involved in the event of unfavorable conditions, such as a drop in property market values or a declining demand. Such an approach is impossible for towers because this building typology prevents any phasing of the investment once the construction site has been set up. Any suspension of the works due to liquidity problems or a significant change in the market conditions means that all investments made up until that time become sunk costs. The unfeasibility of adapting the project exposes the long-term investments not

[2] According to the definition of the *Council of Tall Buildings and Urban Habitat*, a *Super Tall Tower* is more than 300 meters high. As at June 2013, there were officially 73 *STTs* around the world, and 2 *Mega Tall Buildings* (exceeding 600 meters).

only to the market risk, but also to the strictly industrial risk of the vertically-developed buildable capacity. In a review of 60 major projects, Lessard found that the technical risk came second in terms of its incidence, accounting for almost 38% of the overall risk [10].

The block typology thus offers the advantage over the tower of a lower marginal cost. Also, and more importantly, the tower affords little or no costs variability.

The function of the marginal cost in relation to the height of the building is a piecewise linear curve that tends to rise more than proportionally. The intervals mainly correspond to the technological solutions needed to achieve a certain height: the most important factors are the building's elevator systems and other installations [26]. Blocks do not involve cost factors of particular engineering content (such as the wind resistance systems needed for tall buildings), or for special construction site equipment to carry building materials and personnel up to the required height. Even components common to both typologies have a significantly lower incidence on the block typology: for instance, the complexity of the plumbing for the domestic and waste water systems, and the air cooling systems are not comparable because radically different design solutions are needed depending on the height of the building [27]. According to David Langston, the marginal construction cost of a vertical development averages around 25% more than for a horizontally developing building.

Another decisive difference between the two typologies is the construction cost of the external vertical walls (facades), which is highly variable and influential in the case of towers, but readily controllable and well-established for the block typology [28]. The shape and floor area of the tower give rise to different technical and technological solutions for the facades, and their performance in terms of the building's energy containment *must* be much better than for a block because of their greater importance vis-à-vis the total surface area of the building [20]. For a given density, the higher the building (and therefore the more limited the surface area of each floor), the higher the incidence of the marginal cost of the facades. Then we have to add that the surface area occupied by the structural core of the tower (for stability and installations) cannot be compressed beyond a certain threshold, and this gives rise to a considerable discrepancy between the gross surface area built and the floor area that can actually be commercialized. Such problems do not apply to a lower building of the same density.

An efficient building geometry already at the design stage can thus be a decisive factor for the success of a property investment, whatever the economic climate where the development is promoted.

THREE CASE STUDIES IN THE VENETO REGION, ITALY

The analysis and critical review of the literature on the features of production costs was weighed by means of an empirical investigation on projects that underwent a radical revision of the original design choices. Examining several cases led to some preliminary considerations on the importance of design and building typology to the success of high-density developments in the complex scenario of real estate conversions.

Three of the projects examined are mixed-use developments with similar volumes, intended for semi-central areas, two in medium-sized cities, Padua and Bassano del Grappa, and one in the triangle comprising the "territorial system" [29] between Padua, Treviso and Venice. These property developments had in common a decade-long promotion involving an early stage when the project as approved included tower typologies, followed by the plans being set aside due to their economic frailty, then retrieved and implemented after switching to a block typology with the same buildable volume to make the project sustainable.

The development in Padua concerns the so-called Ifip area between the railway station and the trade fair, with a capacity for approximately 150,000 m^3 of residential, office and commercial spaces. In 2000, the public-private partnership responsible for the project planned to build a tower, several smaller buildings, and several important infrastructural works to renovate the road network between the Arcella district, the railway station, the area occupied by the services for the trade fair, and part of the adjacent university complex covering an area of just over 60,000 m^2 [30]. The area's development was subsequently suspended until 2007, when the property owners and the local authorities agreed to revise the project: the original usage and volumes remained the same, but the new masterplan significantly altered the building typologies. Now all the infrastructure for the roads, and for cycle and pedestrian paths have been completed, and the construction site is being set up. Instead of a tower, there will be an urban block layout comprising several six-floor buildings facing onto squares, with internal pedestrian paths, while the roads for through traffic are arranged around the outer edges of the area.

The second project, called Veneto City, was for a large center containing offices, commercial activities and an industrial research pole. The developers wanted to combine innovative processes in the heart of the metropolitan territory of north-east Italy with more traditional commercial and recreational activities in the small towns of Dolo, Pianiga and Mirano, which are equidistant from the cities of Padua, Venice and Treviso. The area affected by the project is very large (more than 700,000 m^2) and includes infrastructure of regional importance such as the future Romea Commerciale motorway, and a new station for the local railways system. The original

project was promoted by the owner, the Veneto regional authority, and the local authorities of the towns involved. It included a system of towers 60 meters tall with more than 500,000 m² of floor area, and 60,000 of this was to be for the science and technology park. The project was much debated and criticized for its size (which was large enough to contain the resident populations of the towns involved twice over). It was held up until 2012 when a new architectural and landscaping masterplan was approved by the regional authority. Here again, the project retains the same overall global consistency, but the architectural solutions have changed completely. The buildable capacity is mainly distributed in buildings with up to 9 floors, only one 60-meter tower survives, and the plan is being implemented with the *preverdissement* technique (meaning that the green environment is stocked before the building starts). The project will be completed in two stages, proceeding with the development of infrastructure and the building works at the same time, and with totally different final heights of the buildings.

The third case concerns the requalification of the Parolini area in Bassano del Grappa (province of Vicenza), which borders on the historical town center, near the railway station and the Trento-Venice railway line. The area was once the site of a gas depot (Italgas) and several manufacturing companies that were abandoned decades ago. It has been the object of a recovery plan ever since 1989. In the years between 2004 and 2008, the consortium owning the area succeeded in obtaining a public-private agreement with the local authority for the construction of several roads and two towers more than 65 meters high, destined for a mixed use (residential, offices and commercial activities). The project was prevented from going ahead by its hostile reception from the local citizens and because of the intrinsic complexity of such a large-scale intervention. In 2012, a variant of the project was approved and the new masterplan involved reducing not only the maximum heights of the buildings, but also the overall volumes. The towers were replaced with a green space surrounded by a set of buildings with a block typology and a maximum height of 25 meters. From the perspective of this article, this third property development underwent the most radical conversion. In doing so, it has regained an economic-financial viability by reducing both the heights of the buildings, and the original total volumes, which are no longer sustainable.

The reasons for modifying large-scale development schemes can vary considerably, but the significance of the above-described cases lies in the direct, prevalent correlation between economic feasibility and choice of building typology. Changes were made not to adjust the allowable usage of the buildings (to prioritize functions more appealing to the market, for instance), nor to significantly reduce the volumes predicted in the original project, which would make the developments less ambitious, but also more sustainable (it was only in the case of Bassano that the buildable capacity was to be reduced). What prevailed in the effort to make the developments economically and financially feasible was the change of building typology. Without claiming to provide a thorough explanation, the proposed examples nonetheless illustrate that, in the uncertain scenario of large-scale property developments, a good way to contain the risks is to reconsider the building typology for the purpose of containing the production costs.

CRITICALITIES OF TALL BUILDINGS: FROM CONSTRUCTION TO MANAGEMENT

The above brief account of three cases underscores how the critically important choice of building typology affects the production phase of real estate developments. The criticalities of tall buildings are apparent even in properties that are completed: for instance, the construction costs of the buildings discussed below made a return on the investment a pipe dream. The reasons why, once built, skyscrapers can be difficult to manage also support our previous considerations on the intrinsic risks associated with vertical development.

The Gherkin, or 30 St. Mary Axe in London is an emblematic case of how the financial exposure needed to build a skyscraper can undermine the profitability of such an investment - even if the building itself is a great success. This is a genuine trophy building, the first and best-known on the new skyline of Britain's capital. Now, nearly 15 years since it was built (costing £138 million) for Swiss Re, the reinsuring company is still the building's prime tenant, together with the Sky News company. The tower has an enviable occupancy rate of 99% of the whole commercial floor area, but this still failed to defend the investment against default because of the enormous debt contracted for its construction, which was shouldered by the property company that bought the building in 2009. The structure of the senior debt, in two different currencies, suffered from the rise in interest rates, even to the point of making it necessary to sell the building to cope with the liquidity issues it had caused. The property was put on the market at a price 23% lower than its purchase price just five years earlier, despite London's dynamic property market and constantly rising property prices.

On the other hand, an example of the "*irrational exuberance*" [31] of the property markets is the One Trade Building (better known as the Freedom Tower) built alongside the Twin Towers site in Manhattan. Only 55% of the commercial floor area available in the building is currently occupied, and the rental prices have been reduced by 10%, from $75 to $69 per square foot per year (still too high, given that the average rental rate in downtown Manhattan is $50). The expected market growth on which the developer was relying did not happen. The demand is not strong enough to support the supply of such a large amount of floor space in an area

already saturated with office buildings. The return on the capital investment of $3.9 billion cannot be assured if the rental income drops any further, so the owner of the land, Porth Authority, has frozen the developer's previously-agreed plan to build a second tower.

This brings us to another emblematic case, what is now the tallest building in Europe, the so-called "Shard" in London. On the one hand, this is a case of urban reconversion through densification. Situated to the south of the Thames, it takes the place of the demolished Southwark Tower. It was intended for a mixed use specifically to reduce the market risk related to single-use development. It required an investment of approximately £500 million and provides 110,000 m² of floor space, which means a production cost of €5600 per m². None of the 36 floors of offices have been rented out to date, nor have the apartments offered at £50 million each found a buyer. The skyscraper has two different problems: the price of the units is inconsistent with its location, which is too far from the City to be comparably priced; and, according to local operators, the building has little appeal because it is so slender that the space on the office floors is scarcely functional.

So, here again, shape is the discriminating factor for the success of a tall building.

CONCLUSION

This study shows how production costs, and especially construction costs are fundamental variables for development projects for the reuse of areas in high-density settings. Costs are naturally always important for the economic sustainability of urban conversion projects, but they can become crucial if the project involves a building typology with a vertical development of the buildable capacity. The hypotheses advanced here, correlating the number of floors in a building (and therefore its height) with rising construction costs are tested by considering two groups of case studies.

The first concerns urban conversion projects characterized by a vertical development of the allowable volumes. It shows that the incidence of the industrial and financial risk of building towers induces various struggling developers to opt for a more "horizontal" approach because of the crucial issue of feasibility relating to their originally chosen tall building typology. The high costs, risks and complexity of the latter can become unsustainable if they are associated with a setting where the income from property rental is low and there is plenty of *greenfield* available.

Efforts to promote suburban projects based on tower building typologies – which are more typical of city centers and market where the pressure of the demand is strong and the cost of land is very high – are an Italian oddity. Adopting such real estate models in markets where land is available and the demand is relatively modest makes it particularly difficult to ensure the economic and financial feasibility of development schemes [32]. It seems clear that underestimating the costs, and the industrial risk in general, is a decisive factor for the success or failure of such schemes. The other group of cases discussed here goes to show, on the other hand, that - even for completed projects - the production costs may impose the need for revenues that are unachievable even in such expansive (but also very volatile) markets as in Great Britain in order to ensure a return on the investment.

The topic discussed here suggests several lines of future research. The literature identifies a by no means homogeneous and unequivocal trend of the costs associated with the increasing height of a building. A broader investigation could lead to the production of a generalizable model capable of reflecting the most significant variables. Such a model could be useful to operators in the building sector, who seem unable to control the industrial process of particularly complex building typologies (such as towers), or even other typologies in more widespread use in our country.

Finally, it is worth noting that, in terms of investment sustainability, the planning stage only considers the economic aspects of a project in terms of a given real estate development, and from a viewpoint that mirrors that of the developer. On the economic plane, no attention is paid to the negative externalities generated by the construction of the complex machinery (especially as regards the energy profile) of tall buildings [33, 34]. How to assess the collective costs of urban density is certainly a topic worth investigating further.

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