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Are China's Future Tall Buildings About to Enter a New Age?

中国高层建筑的未來趋势



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荣智杰先生是凯迪思香港办公室的董事。作为一位经验丰富的管理顾问和特许测量师，他领导着公司在大型城市客户项目的开发，主要关注的城市在珠江三角洲地区，包括香港、澳门、深圳、广州、横琴和珠海。荣智杰为亚洲和欧洲的知名客户工作过，在客户和咨询机构都居于高位。他在指导资产密集型企业的业务转型计划上有很高的专业水平。

Abstract | 摘要

Greater China has experienced unprecedented economic growth, resulting in the development of some of the world's tallest and most iconic buildings. Many view these engineering marvels as part of a local government strategy put their cities on the map. However, the economic and political landscapes have shifted, impacting demand for space, funding and the commercial viability of many developments. Many even question if it is still politically acceptable for cities to pursue such iconic tall developments. Why build 80 stories when the cost of two 40-story buildings is known to be significantly cheaper and more efficient? Economic pressures present opportunities for the industry to innovate and adapt. Three important questions arise: 1) At what point does Chinese wage inflation and falling commodity prices push the industry to greater prefabrication? 2) How will low steel prices affect the height where steel becomes more viable than composite structures? 3) Will developers increase focus on whole-life-costs, sustainability?

Keywords: Commercial, Construction, Cost, Structure, Verticality

大中华区经历了前所未有的经济增长，这带来了一些世界上最高、最有标志性的建筑的开发。很多人把这些工程奇迹看作是政府提高城市关注度的策略中的一部分。然而，经济和政治景观已经转移，这影响了在空间、资金和商业发展可能性等方面的需求。很多人甚至质疑，追求这样标志性的高层建筑在政治上对于城市而言是否仍是可接受的。当建造两幢40层的建筑更便宜且更高效时，为什么要建设80层的高楼呢？经济上的压力给行业带来创新和适应的机遇。三个重要问题出现了：1) 在什么情况下，中国上涨的工资和下降的商品价格会推动工业的预制化水平？2) 当钢结构比复合结构更有可行性时，钢铁价格将如何影响建筑的高度？3) 开发商会增加对全生命周期的成本和可持续性的关注度么？

关键词：商业的、施工、造价、结构、垂直性

What Does the Future Hold for Tall Buildings in China?

Over the last 20 years tall and supertall buildings have increasingly become the norm in China. This has created a stock of assets that are not only incredibly tall, but which have also pushed the boundaries of what is possible from both a technical and architectural perspective. In some cases these very buildings have served to put previously unknown Chinese cities on the map.

This wave of tall buildings has been achieved in an era of unprecedented and sustained economic growth however today, the environment in China is very different. The economy is moving from one which has been fuelled by investment, to one that is increasingly driven by productivity and consumer spending. With GDP levels now being managed towards a more sustainable figure typically associated with mature economies, the days of double digit and high single-digit GDP growth are over.

中国高层建筑的未來趋势

在过去的20多年里，高层建筑与超高层建筑在中国越来越常见。这创造了大量固定资产，这些楼不但高得惊人，而且在工艺技术与建筑学上实现了新的突破，达到了新的可能。有时建造此类高楼是为了让其所在的无名小城广为人知。

这一波高楼潮形成于中国那个前所未有的经济持续增长年代，然而今天，中国的环境已经非常不同。中国经济已由投资驱动逐渐转变为由生产力与消费驱动。随着经济发展日渐成熟，GDP的增长数字趋向平稳，GDP两位数增长与高单位数增长的时代已经过去。

中国的所有产业都会受到上述结构转变而影响，约占中国GDP总量7%的建筑业亦然。经济环境与政治环境的转变也会影响土地需求、资金需求，以及未来楼盘的整体商业可行性。本文将探讨源于该环境转变的一些高层楼房发展趋势。楼层越高建造成本越高，在未来的几年里，这对开发商和整个产业都意味着什么？

No industry will be immune to these structural changes, less so the construction industry which accounts for roughly 7% of the country's total GDP. Shifts in the economic and political landscape will impact the demand for space, funding, and the overall commercial viability of future developments. This paper will explore some of the trends around tall buildings that are likely to emerge from this changing environment, the cost challenges when building tall, and what these will mean for both developers and the industry alike over the coming years.

In producing this paper the authors have examined the following; the economics behind over 40 tall buildings in China that Arcadis has been involved in delivering, plus insight from some of the projects that have stalled over the last 18 months as the economic environment in China becomes tighter.

Future Trends Around Tall Buildings in China

Whilst it's impossible to predict the future, there are a number macro-level factors playing out within China that will have implications for central and local government, developers and the wider construction industry as a whole. Below are five trends that will be prevalent and which are likely to influence the evolution of tall buildings in China over the next decade.

1. The urbanization paradigm – with over 300 million people expected to migrate to China's cities over the next decade, innovative solutions will be required to respond to this demand, particularly in those cities where there is already a scarcity of land and finite resources. Continuing to build tall and increasing density will be a key part of the solution however these assets must stack up financially and this won't be achieved by building more of the same. China will need to be smarter around how and what it builds to create better environments for less money.
2. "Build it and they will come" no longer holds true – in the recent past, China has capitalized on hot markets where developers and consumers have both benefitted from rising prices. However, outside of prime space in Tier One cities this is rapidly becoming a thing of the past. Developers are increasingly holding assets for longer as opposed to taking their capital out quickly and moving on to the next project. Likewise, funders are becoming increasingly discerning and wary of

lending where demand is less certain or rental streams are falling.

3. The death of vanity projects – urban planners and architects are increasingly advising on the need for a new type of urbanism in China, one that's denser but at the same time more sustainable for both the environment and the community. There are extremely strong drivers at play behind this; partly from the markets, partly from occupiers and increasingly so from government officials who want to see fewer 'statement type' buildings. This doesn't mean that great architecture is dead, far from it, but it will mean the death of vanity structures with no value-add.
4. The rise of greener and more flexible buildings – Fortune 500 businesses in China are increasingly looking for better quality, flexible, and more environmentally friendly assets to align with their corporate policies. Demand already outstrips supply today and with new millennial workers likely to demand greener, more engaging workspaces as standard, the next generation of tall buildings will have to reflect the needs of an economy and workforce which is moving much further up the value chain.
5. Smart tall buildings will be the long-term future – in time a combination of market and government directives will see smart, data-intensive, environmentally friendly tall buildings become the norm. However, these currently come with a hefty price tag and unless the industry becomes significantly more efficient, the commercial reality is that these will be slow to be adopted. A truly green building today will typically carry a 7% premium in respect to construction costs and that's before taking into account the integration of better community and social space that's required for vertical urbanism. This figure kills the commercial case supporting most developments.

In examining each of these trends, three key questions emerge; can the industry identify find ways of delivering the next generation of tall buildings in a more cost effective manner? How quickly can this be achieved? And most importantly, what conditions will need to be in place to incentivize the industry to help bring this new era of tall buildings to life?

在本文的成文过程中，作者们研究了中国40多座Arcadis公司参与建造的高楼背后的经济状况，此外本文亦分析了部分因中国经济形势收紧而在过去18个月中处于停滞状态的建筑工程，寻求对现状作进一步的洞察。

中国高层建筑的未來趋势：

尽管未来无法预知，中国国内的某些宏观层面因素仍可为中央与地方政府、开发商，以及更广义的建筑行业提供窥见未来的途径。以下是即将主导的五个趋势，这五个趋势将很可能影响中国未来十年的高层建筑发展方向。

1. 城市化——在未来的十年内，估计有超过3亿中国人将移居城市。中国需要创新的解决方案来应对这个需求，对于那些土地与资源业已见短缺的城市尤其如此。应对的关键是继续建造高楼，增加楼群密度。然而这些资产的经济价值也需要相应增加，这不是单单靠高楼建设就能实现的。中国将要更机灵地决定该怎样建及该建什么样的房子，才能花更少的金钱来建立更好的环境。
2. “房子盖好了自有人来住”已经行不通了——不久前中国好好利用了火热的市场，在这些市场热点中，开发商与消费者都因涨价而获利。但是，在中国一线城市主城区之外的地方，这情况已不再。开发商越来越倾向于长时间把资产收在手里，而不是将资金尽快投放到下一个工程中。同样的，在需求不如从前确定，或租金水平下降的地方，贷款方在放贷时也越来越挑剔和谨慎。
3. 面子工程的终结——城市规划师和建筑师们越来越郑重地建议，中国需要一条新的城市化道路，而新的地方在于，在增加楼群密度的同时，环境和社区的可持续发展都能得到更好的保障。在这背后有多个极强大的驱动因素，这些驱动因素一部分来自市场，一部分来自用家，还有另一个越来越大的部分，来自不想再看到更多“地标工程”的政府。这不是说伟大的建筑就此完结，远不是那样。但这说明没有任何增值能力的面子工程将就此完结了。
4. 更加绿色环保、灵活多用的建筑的兴起——中国境内的财富500强公司正越来越青睐更优质、更灵活多用和更环保的建筑，以迎合它们的企业政策。今天，需求已经大于供应，并且新世代的员工会要求、并以更加环保舒适的工作环境为标准。新一代高层建筑将必须迎合这个正上行于价值

Are Tall Buildings Still Commercially Viable in a Slower Chinese Economy?

A good commercial manager will always advise that from a cost perspective, it's significantly cheaper to build two fifty-story buildings than a one hundred-story building of the same floor area. At its most basic, the taller the building the more likely it is that:

- The cost efficiency per m² increasingly diminishes
- The cost of construction per m² rises significantly
- The operational cost per m² rise significantly

When you factor in the three elements above,

the headline conclusion is that going tall costs significantly more money. More specifically, going tall results in drives higher costs per m² to the foundations, structure, facade, vertical transportation, MEP and lift installations and of course to the preliminaries.

Whilst every building is of course different, and there are numerous factors and caveats to consider, in a scenario where all environmental and site factors are equal, the cost per m² for a 100-story building is typically circa 66% higher than the equivalent cost per m² for two 50-story buildings (Figure 1).

This raises an obvious question; if it cost up to 66% more, why bother building supertall? The answer is that in practice, cost is only one part of the equation and a more pertinent question is the following; will occupiers be prepared to pay enough of a rental premium to offset the costs associated with building tall?

链的经济群体和工作群体的需求。

5. 智能高层建筑会是长期的发展趋势——在市场和政府政策里，智能的、数据密集型的、环保的高层楼房将成为常见建筑。但是，这样的建筑当前仍造价不菲。除非建筑业的生产效率显着提高，否则此类建筑的商业现实是——其普及进程仍将缓慢。目前，一座真正的绿色建筑通常会导致5-10%的额外建造成本，这还不算建设垂直城市化所要求的更好社区与社会空间的开支。这个数据使大部分绿色建筑在商业上没有可行性。

研究这些趋势的时候，三个关键问题出现了：业界能不能找到一种方式来建造下一代高层楼房，使其造价更低，同时仍具有丰厚的投资回报？要多久才能找到这一方式？还有最重要的是，需要什么条件来刺激业界促成实现这一高层建筑新纪元？

在当前中国经济放缓的形势下，从商业角度来说，建造高层建筑是否仍然可行？

一位优秀的商务经理会经常建议，从成本角度来考虑，在建筑面积相等的前提下，建造两栋50层楼房的成本比建造一栋100层楼房的成本要低得多。从最基本的层面来看，楼房越高，越会如下所述那样：

- 每平米的成本效益持续下降
- 每平米的建造成本显着上升
- 每平米的运营成本显着上升

你把上述三点作为考虑因素的话，总体结论就是楼造得越高，成本也明显越高。更确切地说，楼造得越高，其地基、结构、外立面、垂直运输、机电安装、升降机以及工程开办费的每平方米平均成本就越高。

尽管在每座不同楼房，需要考虑和避免的因素也不同，但在所有环境和工地现场因素都相同的情况下，建造一栋100层楼房的每平方米成本通常比造两栋50层楼房的同项每平方米成本高出约60%（图1）。

这就引出一个很明显的问题了：如果成本高出60%，为什么还要建造超高层？答案是，实际上，成本只是考虑的一部分，更切中要害的问题是：用家愿不愿意多付租金，多到可以抵消掉因楼层高升而高涨的建造成本？

图2从某种程度上解答了这个问题。依据随楼层增高而增高的每平方米建筑成本，以及中国一线城市主要办公区域的平均租金

Sample cost model for tall building

Standard Building Element	Unit Construction Cost per m ² Floor Area for Office Buildings in Shanghai, China		
	50 Storey	Premium factor	100 Storey
1. Foundation	5.1%	1.55	7.9%
2. Structure	16.0%	2.92	46.7%
3. Façade	14.6%	1.39	20.3%
4. Architectural interiors	13.9%	1.38	19.0%
5. Vertical transportation	7.1%	1.79	12.7%
6. MEP installations	35.0%	1.27	44.4%
7. Specialised services installations	3.0%	1.28	3.8%
8. External works	0.6%	(Negligible)	0.8%
9. Preliminaries	4.8%	2.13	10.1%
Total		1.66	166%

Figure 1. Sample cost model for tall buildings in China (Source: Arcadis)

图1. 中国高层建筑成本模型示例（来源：凯迪思）

Rental Value Vs Construction Cost

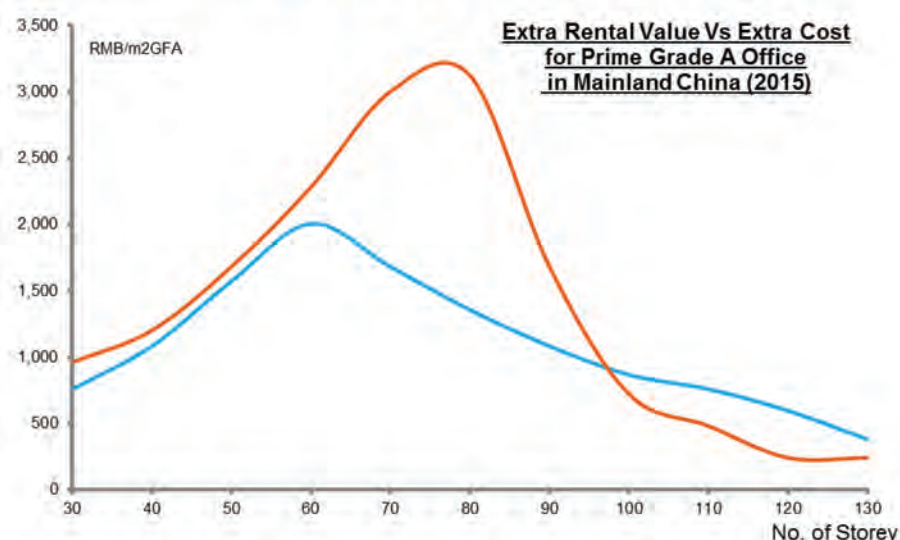


Figure 2. Average rental value vs. construction costs (Source: Arcadis)

图2. 平均租赁价值与建造成本对比图（来源：凯迪思）

Figure 2 goes some way to answering this question. By plotting the height of a building against both the increasing cost of construction per m² and the average rental streams for prime office space in Tier One cities in China, it becomes possible to see the extra value that is typically derived from building tall.

The good news is that despite recent events, building tall still makes strong commercial sense provided there is still market demand for the space. In fact, the evidence indicates that constructing 60 to 90 stories high is where optimum returns are achieved. Even 100+ stories makes commercial sense but only when the asset is situated in the right location.

The Emergence of a Two-Tier Market for Tall Buildings:

Our data shows that the age of building tall in China is very much alive however increasingly the market is moving towards two distinct systems, characterized as follows:

1. Tall buildings in prime locations within Tier one and Tier two cities – in this instance future tall buildings are likely to be super-tall (300m and above) as this is the type of asset that best meets current market demands. These types of tall buildings also typically carry a degree of status which occupiers still place a lot of value on, particularly within China's largest cities. Interestingly, when looking at prime assets in Tier One cities like Shanghai or Shenzhen, graphs like the one above have barely changed over the last 5 years, despite the more recent slowdown in China's economy.

2. Tall buildings in non-prime locations within Tier two and Tier three cities – in this scenario we're likely to see not just tall buildings but also incredibly dense developments. In non-prime locations, this model is the only way to make the commercial case stack up. Pressures on rental values and an increase in vacancy ratios on developments outside of prime space, has resulted in a considerable tightening of the market. It's not that capital isn't available to fund these developments, but more that there is an increasing scrutiny concerning realistic demand, forecast income flows and how this relates to the nature of what is being built (how tall, what volume, what type and whether it provides good ROI). The previous mind-set of "build it and they will fill it" is no longer enough. This type of development will also be key in helping China meet the growing urban demands that their cities will face over the next decade.

In both of the scenarios outlined above our research indicates that there's a sweet spot of between 50–70 stories where the return is highest compared with the upfront capital investment required.

Changing Dynamics in China's Construction Industry:

Whilst the appetite for tall buildings remains pretty solid, particularly in Tier One cities, it's also important to monitor and be able to respond to any material changes within China's construction industry. Interestingly,

水平，来设定待建楼房的高度。这一过程中，建造高层可能带来的额外收益就显而易见了。

好消息是，尽管近期发生的转变，但建造高层建筑仍然很有商业意义，因为土地的市场需求仍然很大。事实上，证据显示，建造60–90层的高楼的收益是最丰厚的。就算是100层以上的高楼仍是有商业价值，前提是楼的选址一定要正确。

中国二线城市对高层建筑的需求开始显现

我们的数据显示，无论市场如何在以下的两个体系转变，中国当前的高层建筑市场仍非常活跃：

1. 位于中国一二线城市黄金地段的高层建筑——在上述区域内，建筑的高度很可能不止高层，而是超高层（300米以上），因为超高层建筑是最符合当前市场需求的固定资产形式。这样的楼房通常在某种程度上是身份的象征，而它们的用户也仍然非常看中此点，在中国最大的几个城市中尤其如此。有趣的是，看看比如上海或深圳这样的中国一线城市里的主要资产，尽管近期中国经济放缓，像上图那样的曲线在过去5年里也几乎没什么改变。
2. 中国二三线城市非黄金地段的高层建筑——在这些区域中，我们看到的不仅仅是高层楼房，还有密集到难以置信的楼盘项目。在非黄金地段，这样的模式是唯一具有商业可行性的。租金的压力，和非黄金地段楼盘空房率的上升导致了明显的市场紧缩。产生上述现象的原因，不是因为有足够的资金可以注入这些楼盘，而更加是因为投资者越来越细究现实需求、预期收入和楼盘对预期收入的影响（楼盘层数、容量、类型及其能否带来高投资回报率）。从前“房子盖好了自有人来住”的思维模式已经不可行。

Construction Cost Trend in China

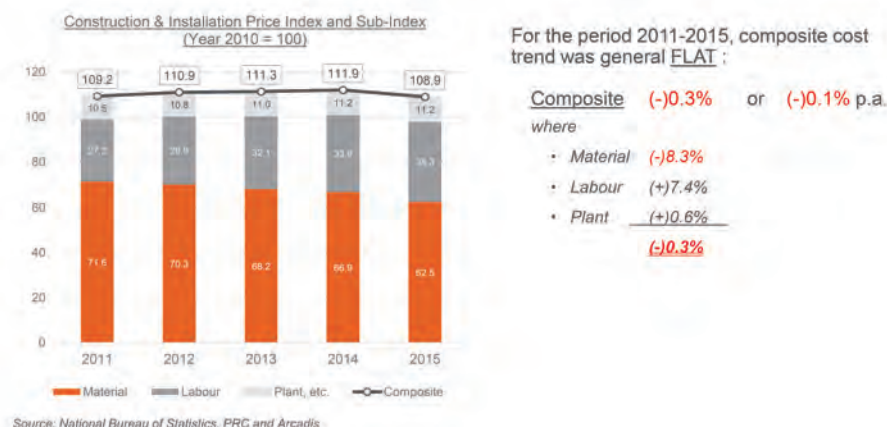


Figure 3. Construction cost trends in China (Source: Arcadis)
图3. 中国施工成本趋势 (来源: 凯迪思)

在上述的两个情景中，我们的研究显示，50–70层之间是理想的层数，把楼盖到这个层数，所得的回报相对于前期投入来说是最高的。这点非常重要，因为有些时候，设计行业对一些商业可行性因素比较敏感，这些因素包括净总面积效率、建筑外立面以及面积比。

中国建筑业的变化动态:

尽管在中国的城市，尤其是一线城市中，高层建筑仍然保持强势，因此监控中国建

Construction Cost Trend in China

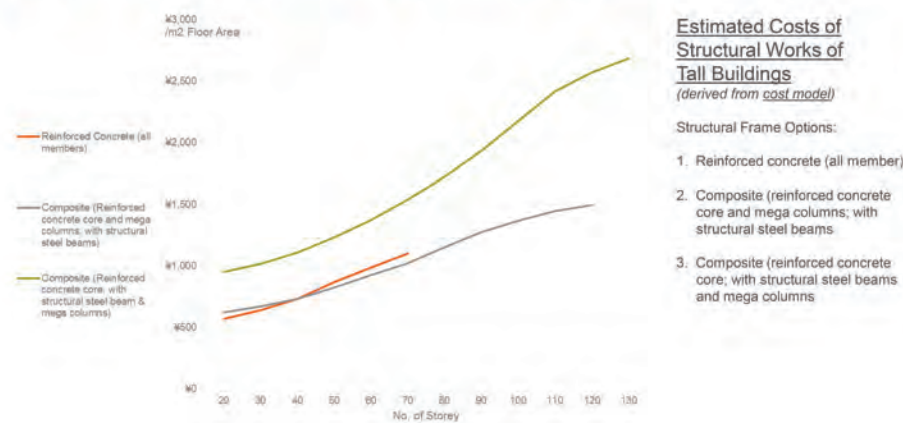


Figure 4. Trends in construction commodities in China (Source: Arcadis)

图4. 中国施工结构框架成本趋势（来源：凯迪思）

construction costs in China have remained pretty static over the last 5 years however that may not be the case over the next 5 to 10 years (Figure 3).

Static construction costs over the last five years are not because China has been building smarter and more efficiently. It's a product of a drop in the cost of materials of around 8%. Almost all commodity costs have dropped, especially steel, however during the same period China has also seen a corresponding rise in the costs of labor within the Tier One cities, particularly for skilled labor. These two factors have cancelled one another out, hence why costs are relatively static.

The health warning however is that this could quickly change if either the Chinese or indeed the global economy picks up and starts driving increased demand for materials. The industry needs to anticipate this and start planning ahead of the curve for a day when this is no longer the case and more efficient construction methodologies are required.

Whilst the majority of the rest of the world builds with steel, China has a rich history of building tall with concrete and composite structures. The wider construction industry is set up to deliver using concrete as opposed to steel and although concrete is viewed as less environmentally friendly than steel, it also requires lower skilled labor, and so it has made and will continue to make economic sense to do so.

Typically concrete frame was the norm up to 50 stories, composite core and columns with steel beams up to 100+ stories, with the switch to a complete steel core and column the exception rather than the rule. These days this is driven the skilled labor available and the supply chain set-up as opposed

to the costs of materials themselves. Even after the economic slowdown and drop in steel prices this has minimal movement in that relationship. Concrete remains less environmentally friendly however with little incentive to change, composite structures will remain the default approach (Figure 4).

What Will This Mean for Developers in China?

Every supertall building will have its own "back story" but over the last ten years there have been too many developments, particularly outside of Tier One cities, that have "stretched" the economic norms. This can be seen in the number of high-profile developments that did not move forward to construction during 2015. Today an increasing number of developer and investor clients are asking for solutions to help "recalibrate" both their existing assets, and future developments plans to help make them more financially viable, especially when it comes to securing funding.

This recalibration is of course is not just about cost it's also about creating a product that best fulfils demand. In a tightening market it's about ensuring that developments are as attractive as possible to investors and occupiers alike. It has to be about both value and cost and delivering a final product that meets the specific demands of the local market.

In order to get off the drawing board we expect the next generation of tall buildings will become denser, probably less tall (less than 70 stories), and, given the political backdrop, almost certainly less grandiose in nature. Part of the commercial reality associated with new developments will be to demonstrate that "Great design needn't be expensive." This is especially important if the next generation of

建筑业的主要变化，并有能力对其做出反应，仍然十分重要。有意思的是，在过去五年中，中国建筑成本的变化不大，但是这种情况在未来的五到十年内将会改变（图3）。

过去五年里，中国的建筑成本变化甚微，不是因为中国的建筑方式更智能高效。而是因为，中国的建材成本下降了大约8%。几乎所有的建材成本都下降了，尤其是钢材的成本。然而，同期中国一线城市亦迎来了劳动力价格上涨，尤其是熟练工的价格。建材成本下降和劳动力成本上升互相抵消，所以中国的建筑成本变化甚微。

一个善意的警告是：一旦中国的国际经济形势变好，然后材料需求增加，这种情况可能就很快就会改变。业界需要预见这一点，并应该在形势发生变化之前就有所计划，以应对行业要求更高效的建筑方法。

当世界上的大部分其他地方都用钢结构来造房子的时候，中国已经有了用混凝土和组合结构来造高层建筑的丰富历史。更大范围的建筑界认可使用混凝土结构，而不是钢结构。虽然钢结构比混凝土结构更加环保，但混凝土结构对劳动力的技能要求更低，所以它已经是，也将会继续是一个节约成本的建造方式。

通常来说，建造50层以下的楼房时，混凝土框架是常用框架，使用钢梁/柱和混凝土芯的组合结构可建造100层以上的高楼，而纯钢芯柱结构就是特例而不是惯例了。近期，熟练工人团体和为降低材料成本而存在的供应链刺激了这一现象的发展。改变的动力仍然很小，所以组合结构仍会是优先选择（图4）。

这对中国的开发商来说，意味着什么？

每一栋超高层建筑都会有它自己的“背景故事”，但是在过去的十年间，超高层建筑的楼盘已经太多，尤其是在一线城市以外，这跟经济惯例是相悖的。这从那些2015年里停建的高调楼盘中就可以看出来。今天，越来越多的开发商和投资者客户寻求能帮他们把已建楼盘和未来楼盘计划“重新定位”的方式，以让它们在财务上更加可行，要确保资金到位的时候尤要如此。

这个“重新定位”不但是指成本，也指建造最能满足需求的建筑。在一个收紧的市场里，“重新定位”意味着确保楼盘对投资者和用户的吸引力越大越好。这必须和价值、成本，以及满足当地市场的特定需求挂钩。

为了不停留在图纸阶段，我们预期下一代的高层建筑楼群密度会更大，可能没那么高（70层以下），并且考虑到政治背景，

green, data rich and sustainable environments are to be delivered early enough to support China's changing economy and the desire to be more environmentally friendly.

Driving down operational costs is another key area that developers will need to focus on more acutely in the future. Tall buildings are expensive animals to operate. MEP for example is not only expensive to install, it's also very expensive to run (energy, labor and materials), maintain, upgrade and ultimately replace. This is just one of a number of areas within tall buildings that must be considered at the outset if development plans and business cases are to be optimized.

However, of the great stock of tall buildings that China has constructed over the last 20 years, few developers have historically been interested in approaching buildings on a lifecycle basis. In the past whole life-cycle costing has not been considered as, often, the view has been that replacement costs down the line will be someone else's problem, or can be passed on to the occupants.

This mentality is starting to be challenged though largely due to two key economic factors:

1. Occupiers – increasingly, anchor tenants that have typically occupied

the upper floors of tall buildings are seeking to drive down their operating costs. The financial sector is a key mover in this space and in the future they are likely to have a tighter operational price point and the developer's ability to pass on all operational costs will be capped and curtailed.

2. Changing developer strategy - there is a definite move in China towards developers constructing and holding buildings as part of long term portfolio investment strategy as opposed to getting the money out early and moving on to the next project. This will mean developers have to take a greater degree of interest in the quality and whole life costs of a building as it will affect their bottom line. This mirrors the approach already being taken in more mature markets (Figure 5).

So whilst whole-life costs have not been a key component of many of the tall buildings constructed over the last 15 years, the industry in China is going to have to adapt, learn new skills and find ways to achieve this at minimal or nil cost construction premiums.



Figure 5. The lifecycle opportunity with tall buildings (Source: Arcadis)
图5: 高层建筑的生命周期 (来源: 凯迪思)

造型也不会那么宏伟辉煌。关于新一代楼盘的一个商业现实将是, 它们将证明“好的设计未必一定很贵”。如果新一代绿色环保、信息密集和可持续性的生活环境能够早点建立, 能支持中国经济转型, 而且社会需求也更趋于环保的话, 这就尤为重要。

减低运营成本是未来开发商们要关注的另外一个关键点。高层建筑的运营费用非常昂贵。比如说, 高层建筑的机电安装不但建造费高, 运行费用(能源、人工和材料)、维护费、升级费和更换费也很高。

中国过去20年所造的高层建筑里, 鲜有开发商会考虑建筑的生命周期。过去, 人们并不考虑建筑的生命周期成本, 通常的想法是, 更换费反正是别人的事, 要不是用户的事。

然而因为以下两个关键经济因素, 这种想法开始备受质疑:

1. 用户——常居高层建筑高层的那些主要租户渐渐要求降低他们的运营成本。未来他们很可能收紧运营支出, 开发商转嫁全部运营成本的能力也就受到制约。
2. 开发商策略的变更——中国开发商们的投资策略会发生根本改变。以往他们会早早把资金从前一个楼盘中抽出, 以注入下一个楼盘; 而他们现在会把在建楼盘和已建成楼盘视作长期投资组合策略的一部分。这意味着, 开发商们必须大幅加大对建筑质量和其生命周期成本的关注度, 因为这会影响他们的收益(图5)。

所以, 虽然过去15年建造的许多高层建筑没把整体生命周期成本作为关键考虑点, 中国的建筑业也将不得不学习和采用新技术, 并找到一个方式, 以最低或者零额外成本为代价来实现这一点。

建筑业能进化得够快吗? 更大规模模块建筑的案例:

现在越来越常听到这样的声音: 政府喜欢看到更干净、更智能的建筑, 喜欢看到一个不再那么依赖廉价劳动力, 而是提供高薪岗位的建筑业。我们是否会看到, 将来某天, 中国的施工团队使用在工地外预制的部件来“组装楼房”而不是“建造”楼房。

对于今天的大多数开发商来说, 这种做法的经济效益通常不高, 所以没什么动力这么做。就目前的经验来看, 使用大量模块预制件来建造高层建筑可导致成本

Can the Industry Evolve Quickly Enough? The Case for Greater Modularisation:

It is increasingly being heard that the government would like to see cleaner, smarter construction and for the industry to become one which relies less on cheap labor and which instead provides more highly paid jobs. Will we see a day in China when contractors use far more offsite modularization to “install tall buildings” rather than “construct” them?

For most developers there is little incentive today to do this as it rarely makes good economic sense. Current experience suggests that attempts at mass modularization on tall buildings have resulted in costs actually increasing by up to 15%. This is largely due to the impact of logistics which are expensive in China, particularly in prime locations where land tends to be quite congested and access constrained. Where site conditions support low cost modular logistics, the best cases indicate circa 5% reduction in costs

However, experience from other industries shows that when supply lines are set up to enable manufacturing and industrialization principles to be introduced, significant drops in costs arise after the initial investment period. The problem with the construction industry as it stands today is that compared to the utilities or oil & gas sectors, it is highly fragmented both in terms of product design and the parties involved.

If you take an aircraft carrier (circa 340 meters long) and turned it vertical so that its bow pointed to the sky, it actually compares with the height and volume of many of the tall buildings built in China today. The US Navy has just commissioned a series of 5 aircraft carriers, the first of which is the Gerald Ford. They are targeting a 10% reduction in the cost of building each subsequent vessel. Why don't we take the same mentality to the next generation of tall buildings in China? This level of savings could make it economically viable to build greener, more sustainable, data rich tall building over the coming years.

There are some green shoots of modularization of buildings happening, however it's relatively minor and will not create the step change required to enable tomorrow's buildings to be delivered at today's prices. As things currently stand it would take a major shift to create a manufacturing type supply chain that can reduce costs by up to 15%. It would require significant investment in new manufacturing facilities, far better logistics capabilities and the introduction of new skills to the industry. It

would also require far greater standardization and visibility of order books for manufacturers. Without this, the front end investment required to achieve this will not occur.

This vision is not as far-fetched as one might think. Many of the world's leading architects working on tall buildings in China today are already adopting very similar design components, but they are not being coordinated in a way that would enable a manufacturing mentality to transform the current supply chain. This need not create monotonous design; in the car industry a Volkswagen Golf and a Skoda share the same components, and they look very different and are also aimed at two very distinct markets.

Whilst recognizing the need for tall building to be able to differentiate them, perhaps many of our buildings today are a little bit too different; not just in final product, but also in how they are created. Figure 6 is a useful representation of the complexity of designing tall buildings. It also demonstrates that the knock on effect of changing a couple of elements is significant from a cost perspective. Experience from other industries shows that it's quite easy to lose the opportunities of applying manufacturing principles by introducing design changes that add little value compared to the opportunity costs e.g. there can be a 40% price hike between a simple asset and a statement one (Figure 6).

When it comes to the usage of BIM there are similar cost benefits to be gained however as above, this will require a much larger and faster change in the level of standardization. Those firms who get their first and find the

上升达15%。这主要是因为中国的物流费比较贵，尤其是在拥挤、通行不畅的主要地区。如果是在能够低价运输预制件的地区，在高层建筑中运用模块预制件，最佳的案例能节约大约5%的成本。

然而，来自其他产业的经验表明，当新的供应链形成，使大规模生产和产业化可以实现的时候，成本相对于投资初期会大幅下降。这或许也会带来更高水准的质量管理，以及生命周期成本的降低。今天建筑业的问题是，和公共事业或油气业相比，建筑业的产品设计和行业持份者都非常分散。

如果你把一艘航空母舰（约340米长）竖起来，让它船首对天，它的高度和容量就跟现在中国大部分的高层建筑相当。美国海军刚刚委托建造了五艘航母，第一艘是杰拉尔德·福特号。他们的目标是，后续的每一艘航母，成本都要降低10%。对中国的新一代高层建筑我们为何不能抱同样的决心和理念呢？在未来的几年里，节约的额度可以使成本不再成为阻碍建造更绿色环保、可持续性、数据密集的高层建筑的原因。

现在已经有一些模块预制建筑的案例，但是相对较少，而且这些案例也无法促成大的改变。而以今天的造价来建造设想中的新一代建筑，需要一个大的改变。就现在的情况而言，如果形成一个工业化生产型的供应链，事情就会大有不同，而成本降低可达15%。这就要求投资新的生产设施，大幅提高物流能力，以及引进新技术，同时也要求建筑业的产品更加标准化和对需求的可推断性。没有这些，就没有引来这个设想的前期投资。

这个设想不像有些人想的那么牵强附会。当下许多在中国建造高层楼房的国际顶尖

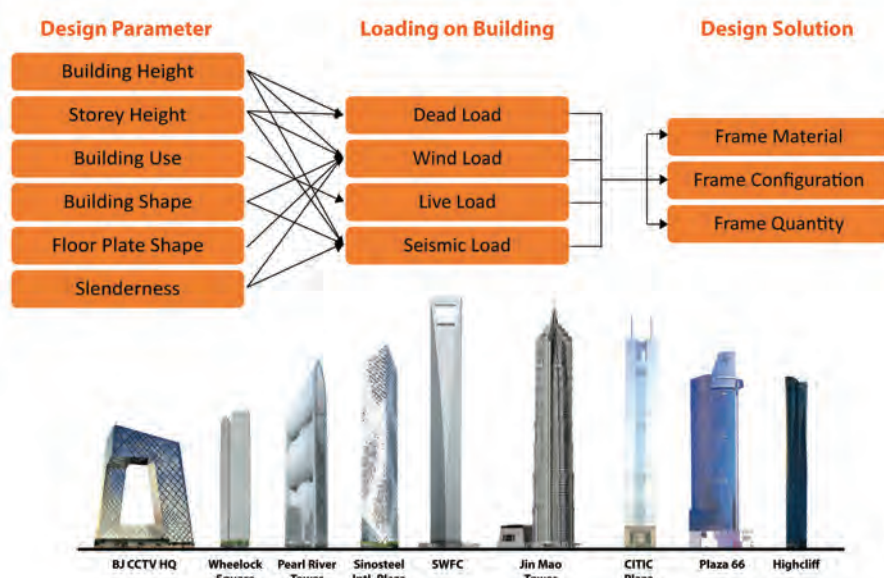


Figure 6. Inter-connections within tall buildings (Source: Arcadis)
图6：高层建筑内在联系分析图（来源：凯迪思）

right balance will get the premium before the wider industry catches up.

The Role of Government in Accelerating Development of New Tall Buildings:

The challenge facing the construction industry is that not only is it a major employer of low skilled workers but its success is built on the ability to capitalize on this relatively low paid workforce. The mass movement of the industry towards more efficient construction such as manufacturing methodologies is unlikely to change until either rising labor costs or some form of government intervention make this a necessity.

With that in mind it's clear that the government has a vital role to play in making this happen at a pace that will have an impact on the next generation of tall buildings in China. A smart approach would be to first prove what's possible, i.e., pilot a small number of schemes to create the belief around what's achievable and the industry will follow. Other industries have achieved similar results so there's no reason why the Chinese construction industry can't do the same with tall buildings.

If the government openly selected a few pilot projects and invested in the creation of the necessary supply chain including design, manufacturing and logistics needed to deliver the next generation of tall buildings at less than what it costs today, it would create a transformational shift in the industry. This is not just about delivering a building cheaper; it's about delivering the truly green and sustainable environments that will underpin the success of China's increasing urbanization.

建筑师已经在采用相似的设计元素，但是这些尝试还没发展到可能形成工业化生产理念，并改变现有供应链形态的程度。这不需要单调的设计。在汽车产业，大众高尔夫和斯柯达使用同样的部件，但是它们的外观迥异，目标客户群也不同。

高层建筑物有必要互不相同，但是也许我们今天的建筑物之间差别过大了，不只是成品的差异，还有建造过程的差异。从下图可见设计高层建筑的复杂性。下图也显示，改变几个设计元素，就能有效改变成本支出水平。其他行业的经验表明，如果设计的一些变更，相较于机会成本，只能带来非常少的价值，那么很容易会丧失进行大规模生产的机会，例如：地标性楼房的造价，可比简单楼房高出40%（图6）。

建筑信息模型（BIM）的运用也能带来相似的成本效益。但是就像上面说的那样，这会要求更大程度以及更快速度地提高标准化水平。最先尝试并找到合适平衡点的公司，在同行追赶上它们的进度前，它们就会实现利益最大化。

政府在促进新一代高层建筑发展中的作用：

建筑业面临的挑战是，它不但是低水平劳动力的主要雇主，它成功与否也要看它利用这些相对廉价劳动力的能力。在劳动力价格升高，或者政府干预促成劳动力价格升高之前，建筑业仍只能走在朝向更高效率建设方式的路上，而无法真正到达。

由此可见，政府的作用非常重要——政府可以加快变革的速度，从而影响中国下一代的高层建筑。有一个聪明的做法是首先证明什么是可能的。比如，进行小数量的试点工程，让整个行业相信可以得到什么，这样整个行业就会追随。其他产业已有了此类尝试与成就，所以中国建筑业在高层楼房建造中也可以做到。

如果政府公开选择了一些试点工程，并投资建立它的必要供应链（包括设计、生产、物流），使下一代建筑物的造价低于今天，那整个行业将会发生革命性的转变。这不仅是为了造出更便宜的楼房，这是为了造出真正绿色环保、可持续性的生活环境，以助中国成功应对日趋加深的城市化。