CONSTRUCTION INDUSTRY COUNCIL
建造業議會

AEDIFICE 築目

The Journal of Hong Kong's Construction Industry 香港建造業期刊

May 2014
Inaugural Issue
2014年5月號
創刊號

FOUNDING CHAIRMAN

KEITH KERR

RELECTS ON THE CIC's ACHIEVEMENTS

創會主席

簡基富先生

回顧創會道路

ISSN 2312-6167

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About the Construction Industry Council

The Construction Industry Council (CIC) was formed on 1 February 2007 under the *Construction Industry Council Ordinance* (Cap. 587). The CIC consists of a chairman and 24 members representing various sectors of the industry including employers, professionals, academics, contractors, workers, independent persons and government officials.

The main functions of the CIC are to forge consensus on long-term strategic issues, convey the industry's needs and aspirations to government, provide training and registration for the construction workforce and serve as a communication channel for the government to solicit advice on all construction-related matters.

《築目》編輯委員會

《築目》是建造業議會（議會）每半年出版一次的免費期刊。《築目》編輯委員會（編委會）歡迎各界向我們表達意見、觀點和投稿，並接受中英雙語稿件，唯是否採納及發表將由編委會決定。讀者如欲與《築目》編委會聯絡，可透過電郵 corpcomm@hkcic.org、電話 (852) 2100 9000、傳真 (852) 2100 9090 等方式，或郵寄至香港灣仔告士打道 138 號聯合鹿島大廈 15 樓建造業議會。

關於建造業議會

建造業議會根據《建造業議會條例》（香港法例第 587 章）於 2007 年成立，由一位主席及 24 名成員組成，成員來自代表業內各界別的人士，包括聘用人、專業人士、學者、承建商、工人、獨立人士和政府官員。

議會的主要職能是就長遠的策略性事宜與業界達成共識、向政府反映建造業的需要及期許，為業內勞動力提供培訓及註冊，並為政府提供溝通渠道，取得與建造業所有相關事項的意見。

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Chairman's Message

Welcome to the inaugural issue of *Aedifice*, a new publication by the Construction Industry Council (CIC), that sets out to be the journal of and for the Hong Kong construction industry.

Each issue of *Aedifice* is intended to reflect the dynamism of Hong Kong's construction industry, showcasing latest developments and innovations, feature an in-depth interview with a prominent industry figure, and invite contributions from the local industry stakeholders and construction-related organisations outside Hong Kong.

This new publication marks another development in the CIC's commitment to providing various platforms for the industry to communicate and to enhance the sharing of relevant information.

The English title *Aedifice* is derived from the Latin word for 'building' and 'to build' or 'establish'. The Chinese title combines the characters for 'construction' and 'detail' which together can be interpreted as 'Construction Encyclopedia'. The CIC is looking to build on its achievements to date to help the construction industry to keep building a better Hong Kong and record those developments through this journal.

It has been more than a decade since the landmark *Construction Industry Review Committee (CIRC) Report* was released in 2001 which has been a pillar for the reforms in Hong Kong's construction industry and provided the foundations for the establishment of the CIC. One of those who played a leading role throughout that process and was appointed as the founding CIC Chairman was Mr. Keith KERR. He reflects back on that time of transition and the challenges he faced in an interview in this issue. It is a reminder to us of how much has been achieved to date since 2001.

The *CIRC Report*, which became known as the *TANG Report* in recognition of the Committee's Chairman Mr. Henry TANG, outlined 109 recommendations relating to all aspects of the construction industry. The recommendations led to the establishment of the Provisional Construction Industry Co-ordination Board which oversaw the setting up of the Construction Industry Council.

Since its establishment in 2007, the CIC activities have been anchored on the tasks listed in the *TANG Report*. Now that most of these recommendations have been accomplished or met to varying degrees, the CIC needs to develop a new strategic direction based on agreed future activities and goals. Late last year, the CIC held a retreat to bring together Council members representing the various industry stakeholders to review the strategic direction of the CIC and to establish a consensus regarding the way forward.

The CIC has now decided to start work on the development of a strategic plan covering the next 10 years, a report which will be the successor to the *TANG Report*. We are now working out a framework for the report which we expect to start within the year by engaging a consultant to work with the CIC and its stakeholders on short, medium and long term plans and recommendations for the Hong Kong construction industry through the next decade.

In response to the deliberation at the retreat, the CIC has restructured its standing committees and revised their corresponding terms of reference to better reflect changing priorities in construction and to be able to address the specific demands from the Hong Kong industry.

In this issue of *Aedifice*, the chairmen from the restructured committees, namely the Committee on Construction Safety, the Committee on Environment, Innovation and Technology, the Committee on Procurement and Subcontracting, and the Committee on Productivity and Research, have each written a message explaining the changes to the respective standing committee, and the corresponding priorities and activities for 2014.

Safety remains the top priority for the CIC and we have ongoing engagement with the industry to achieve our goal of zero accident. We are constantly exploring how we can instill a safety culture in the mindset across the industry. We are also looking at how technology can improve construction site safety. Due to its climate, heat stress throughout Hong Kong's summer months poses a real danger to workers every year. In his research paper,

Professor and Interim Dean of the Faculty of Construction and Environment at the Hong Kong Polytechnic University, Professor Albert CHAN, outlines how a combination of work practices and innovative clothing can help protect construction workers working in hot weather.

To encourage the wider adoption of building information modelling (BIM) in Hong Kong, the CIC has taken the lead in collaborating with stakeholders on several initiatives to date. In April this year we launched BIM Year 2014 – a programme of conferences, seminars, workshops, events and publicity activities to raise the profile and knowledge of the benefits of BIM. One of the leading proponents of BIM who has done extensive research into its business value over the past decade is Dr. Calvin KAM of Stanford University, who with his colleagues has contributed a practical framework for the effective implementation of BIM.

One of the changes to the industry culture championed by the CIC has been for a shift towards more partnering and collaboration between the various parties. In a comprehensive article, Mr. Damon SO and Ms. Joyce LEUNG of law firm Hogan Lovells look at the various management tools which may be adopted to effectively manage risks between employers and contractors as well as examine some recent legal developments.

Last year, one of the CIC's milestone achievements was the launch of the first product-based carbon labelling scheme for construction products in Hong Kong. It was the result of one of the first collaborations by the CIC with academia through its research funding programme and is evidence of the practical outcome from such research projects aimed at improving Hong Kong's construction industry. Dr. Thomas NG of the University of Hong Kong talks about how the scheme came about in this issue.

At the CIC Conference 2013 we signed a memorandum of understanding with Constructing Excellence of UK, to facilitate the sharing of knowledge and experience, and to work closer together on areas of mutual interest. I am delighted that Constructing Excellence's Chief Executive Mr. Don WARD has contributed an article giving an overview of the strategic direction the UK is taking in the development of its construction industry based on the *Construction 2025* Report.

LEE Shing-see, GBS, OBE, JP
Chairman, Construction Industry Council

What stands out from this international approach to collaboration are common themes that cross borders. Only through adopting new technologies and working in more innovative ways can we realise the productivity we need to keep Hong Kong's construction industry competitive in a globalised world.

I hope you find the inaugural issue of *Aedifice* useful, informative and entertaining, and as always at the CIC we welcome your feedback.

建造業議會

主席的話

歡迎閱讀《築目》創刊號。《築目》是建造業議會（議會）專門為香港建造業編纂，並屬於建造業界的刊物。

在每一期《築目》中，您會見識到香港建造業的動感和活力、窺見業界最新的創意和發展動向、分享業內傑出人士的成功故事，並拜讀本地持分者以至海外建築相關組織撰寫的文章。

為業界提供溝通平台是議會的承諾之一，這本全新刊物再次提供了新的渠道讓業界分享知識。

本刊的英文名稱《Aedifice》在拉丁語中有「建築」和「建設」或「建立」的意思。中文名稱則取建「築」綱「目」之意，因名《築目》。議會希望在現有的基業之上，進一步協助建造業界建設更美好的香港，並以本刊記錄業界的發展進程。

於 2001 年發表的《建造業檢討委員會（建檢會）報告書》是香港建造業改革的中流砥柱，亦是議會成立的基石。十多年轉眼過去，整場改革運動的領導人之一、議會創會主席簡基富先生今天接受我們訪問，談及那段過渡時期中面對的各項挑戰，讓我們看到從 2001 年一路走來的各項成績。

當年由唐英年先生出任建檢會主席，提交了名為《建業圖新》的報告書，其中就建造業各個範疇提出的改善措施達 109 項，更促成了臨時建造業統籌委員會（臨時建統會）的成立，以監督建造業議會的整個成立過程。

自 2007 年成立以來，議會舉辦的活動一直在履行《建業圖新》報告書中列舉的任務。今天，大部分任務經已完成，其餘的也發展至一定程度，因此議會必須為日後的工作確認目標及制訂策略。去年年底，代表業界不同持分者的一眾議會成員舉行了集思會，重新審視議會的策略性方向，並為未來發展路向尋求共識。

議會決定草擬一份未來十年的策略性計劃，作為《建業圖新》報告書的延伸。我們現正為報告書訂定框架，期望在年內聘請顧問與議會及各持分者共同就香港建造業提出短期、中期和及至未來十年的長期計劃及建議。

為回應是次集思會的討論，議會重組了轄下各專責委員會的結構並重新審視各會的職權範圍，使之更能反映建造業焦點的轉變及回應香港業界的具體訴求。

重組後的專責委員會分別為建造安全專責委員會、環境、創新及技術專責委員會、採購及工程分判專責委員會、以及生產力及研究專責委員會，各會主席均於本期《築目》中撰文，闡述其專責委員會的變動及 2014 年的目標和主要活動。

安全始終是議會的首要任務，因此我們與業界長期合作以達至零意外的目標。我們不斷尋求方法為整個行業灌輸安全文化，亦嘗試利用科技提高工地安全。受氣候影響，本港每年夏季均分外酷熱，嚴重威脅工人的健康。香港理工大學建設及環境學院暫任院長及建築及房地產學系教授陳炳泉先生在本刊中介紹了一套配合工作模式和高科技服裝的方法來保護於炎熱天氣中工作的工人。

為鼓勵在香港更廣泛地採用建築資訊模型（BIM），議會率先與各持分者攜手推出多項措施，並將於今年四月展開「2014 建築資訊模型年」。這個包含會議、研討會、工作坊、宣傳和推廣項目的全年活動，將提高大眾對 BIM 及其好處的認知。史丹福大學的甘嘉恒博士是 BIM 的主要倡導者，過去十年就其商業價值進行廣泛研究，他與他的團隊在本刊中提出了一個切實的框架有效地推行 BIM。

業內其中一個由議會帶領的文化轉變，就是越見普及的夥伴合作和協同作業。霍金路偉律師事務所的蘇睿哲律師和梁曙慰律師在本刊中全面解構各種有效管理僱主和承建商之間風險的管理工具，並探討近來的相關法律發展。

議會去年的重點成績之一是於香港推出首個產品碳標籤計劃。這是議會初期向學界提供經費的合作研究項目之一，印證了此類實務性研究項目在改善香港建造業方面的成效。香港大學的吳兆堂教授將於本刊中詳述整個計劃的來龍去脈。

在 2013 年建造業議會研討會進行期間，我們與英國 Constructing Excellence 簽署了一份諒

解備忘錄，促進知識和經驗的交流，加強雙方在共同關心的領域上的合作。我很高興這次邀得 Constructing Excellence 的行政總裁 Don WARD 先生為我們撰寫了一篇文章，細說英國在《Construction 2025》報告的基礎上為建造業訂立的策略性發展方向。

超越地域界限與國際性的團體協同合作，讓我們了解到大家共同面對的大小問題。唯有採用最新的科技，配合創新的工作模式，我們才可以保持香港建築業的生產力和競爭力，在全球化的大時代中繼續昂首向前。

希望您喜歡《築目》這本資訊和趣味俱備的刊物。一如以往，議會期待聆聽您的寶貴意見。

李承仕，金紫荊星章，OBE，太平紳士
建造業議會主席

Aedifice Interview: Mr. Keith KERR

Industry veteran Mr. Keith KERR is a man familiar with the view from the top. As Chairman of Swire Properties he oversaw some of the landmark developments in Hong Kong. As President of the Real Estate Developers Association of Hong Kong (REDA) he has played an influential role in the property sector. As a mountaineer he has climbed the Seven Summits. And, as the Construction Industry Council's founding Chairman he set the course of the nascent organisation. In an interview with *Aedifice*, Mr. KERR looks back at a defining time for Hong Kong's construction industry and assesses where we are today.

Hong Kong's construction landscape was very different at the turn of the millennium than it is today. Following the breakneck boom through the 1990s to complete iconic projects related to the Airport Core Programme and the Hong Kong Conference and Exhibition Centre ahead of the 1997 Handover along with other major infrastructure works, the construction industry found itself in a parlous state following the Asian financial crisis. In response, the Hong Kong Government set up the Construction Industry Review Committee (CIRC) against a backdrop of soaring unemployment among construction workers as major projects were completed and an industry rocked by the short piling scandal.

"I think we were post the construction bubble that led up to the opening of the airport so there was quite high unemployment rate in the industry probably around about 19 percent which was higher than other industries and so those were two key factors that caused the formation of the CIRC," Mr. KERR recalled. "Of course there were all sorts of other issues associated with the industry which was very fragmented but the catalysing impact were the short piles and the unemployment and the need to try to rebuild an industry that had been quite badly damaged by the drop off in the volume of work."

In April 2000, the HKSAR Chief Executive appointed the CIRC chaired by Mr. Henry TANG, then a member of the Executive Council, to comprehensively review the state of the construction industry and to recommend improvement measures. Mr. KERR, who was Managing Director of Swire Properties at that time, was invited to join as one of the 16 members of the CIRC. The CIRC submitted its report entitled *Construct for Excellence* to the Chief Executive in January 2001. It recommended 109 improvement measures covering the whole spectrum of construction activities to raise the quality and cost-effectiveness of the industry.

One of the key observations in the report was that while being a main pillar of our economy, the construction industry was highly fragmented and beset with an adversarial culture

which impeded long-term development. It concluded that a statutory industry co-ordinating body encompassing all key sectors should be formed to promote the culture of self-regulation in a market-driven environment.

The Provisional Construction Industry Co-ordination Board (PCICB) was formed in September 2001 to spearhead industry reform and to pave the way for the early formation of the statutory body. Mr. KERR was appointed as PCICB Chairman a year later in September 2002.

"The industry was in quite a difficult state at the time as was the development industry," Mr. KERR said. "We'd been through the financial crisis, short piles and bird flu and later on SARS and of course the property market was way down and government spending had dropped after the airport had been finished so there was a "can-do" attitude about trying to get things moving again. In fact in a way some of the client bodies led primarily I think by Russell BLACK who was the Project Director of the MTRC and one or two of the private sector construction companies had already started an informal gathering to start discussing these issues so it had a little bit of momentum already generated by the private sector and once the Government formed the CIRC and the PCICB a momentum gathered about providing a platform to address the challenges of the industry.

Mr. KERR's role in the PCICB then was to steer what form the statutory body was to take, who was going to be appointed to it, how were they going to be appointed, what was its scope, what was its role, how was blood to be refreshed every so often with new faces and new ideas, and what was the operating structure of the subcommittees, focus groups and task forces. The funding would come from the then Construction Industry Training Authority that already had an industry levy in place.

"When I took over the chair my focus was not so much as Chairman on solving the industry's problems as there were other better qualified people than me to address those issues but to try to provide the structure with which those people could address the then key challenges or priorities

of the industry and of course to build an organisation that had some robustness around it that could continue on in the longer term. So my focus was not on the shorter term immediate challenges although I was aware of them but more about trying to build an organisation that could carry this forward beyond my days.

"I was more focused on what you might call the HR and admin issues rather than solving all the industry's problems and when we got things set up I ended up chairing the PCICB and later the CIC. I had to get those basics in place in order to anchor the organisation and give it a basis to move forward."

To achieve the objective of setting up of the statutory body, the *CIC Bill* was first introduced into the Legislative Council in February 2004 and was enacted as the *CIC Ordinance* on 24 May 2006. The CIC was then established on 1 February 2007 to take over the work of PCICB to help represent all the aspects of the industry in order to be a platform to address the challenges that had been identified in the *Tang Report*.

"The legacy has been the formation of the CIC and I hope an industry that is much more cohesive today at least in having a forum to address and identify issues. Whether they are all being resolved is another matter."

In April 2011 Mr. KERR was elected President of REDA, an industry association whose primary focus is to address matters related to the property sector be it land policy, planning issues, building regulations, construction, marketing and legal issues, and one of the specified bodies represented on the Council.

"We do have a construction subcommittee on REDA which I set up at the time I was involved with the CIC because I felt it was necessary to be more focused on the issues of the construction industry but a lot of people in REDA that we deal with regularly are more on the land and planning side. I think we felt at the early stages of the PCICB and later the CIC, and in fact one of the reasons I was asked to be Chairman, it was thought there should be a client-led push because if the clients don't lead nothing much can happen. It's no disrespect to the rest of the industry but he who pays the piper calls the tune basically.

"So whether the client is government or a private developer they need to lead the way. The Government is in a better position to encourage those organisations to work towards and support those initiatives put out by the CIC. It's not easy for the private sector to have one overriding enforcement mechanism."

Mr. KERR elaborated that REDA had done a great deal to encourage members. However, REDA could only encourage but not enforce. Some developers actually got more involved in the work of the Council and some less so. He said it is hard to have a unanimous view among developers on everything.

"The private sector is more fragmented [in implementing CIC's initiatives]. And don't forget the private sector unlike the Government is highly competitive with each other. You mustn't overlook this point because there's a misconception in Hong Kong that it isn't competitive. We have very high land costs and rising construction costs, so in order to stay competitive developers will look at where they need to comply with something and where they can save money."

He said certain industry issues will never be eliminated such as health and safety which require continuous effort. But the main issue now is how the industry can

adapt going forward and become more productive, and how much use we are making of technology to be more efficient and effective. These will be issues the CIC will need to consider in coming up with the framework for its planned industry review and strategy up to 2025.

"Some of the problems that were identified in the *CIRC Report* have been dealt with while some are still works in progress. That goes into broader questions which are very political like how do you deal with the size of the workforce and the training and do you allow flows across the border and so forth. It's a very tricky political issue.

"It's putting pressure on the industry now. I don't know who's benefitting because contractors are losing money because they put in fixed price contracts and they can't manage their costs. The private sector is having to make huge provisions for cost increases and that is going to affect land costs and flat prices. I think there are some significant issues around costs and manpower of a different nature to the ones that existed when all this started."

Mr. KERR remarked that at that time there was insufficient construction work whereas now there is an excessive amount of projects proceeding concurrently. "I suppose the Council will go through what the CIRC did and identify what it sees as the principal challenges of the industry today. I have to say one of the questions that we really must address is cost and efficiency because one of the challenges that I see in the industry today is costs are really spiralling out of control, so we've gone from famine when the CIRC and the PCICB and the CIC were all founded to feast when now there's so much work being pushed out primarily or significantly by the public sector."

He said that the stresses and strains on the industry now would have knock on effects down the line. Some of these were positive such as wages and incomes of workers going up which was bringing up the less well off members of society and also provided encouragement to enter the industry. However, it did give rise to questions regarding the long term sustainability of the industry.

"What's going to happen when the risk is this expenditure stops all over again? One of the things I had been keen on in my time especially towards the end of my term as Chairman of the CIC was to use the planned public expenditure on public works wisely in a way to try to reorganise and restructure the industry in a positive way and address some of these factors."

Mr. KERR was to remain as CIC Chairman until February 2010 when he was succeeded by the current Chairman, Mr. LEE Shing-see. After 35 years with Swire Properties, Mr. KERR now runs his own company, a boutique developer based in Hong Kong, focusing on residential and commercial properties across Asia. While not as close to the issues as he once was, he said he saw the current boom in Hong Kong's construction industry as offering an opportunity for the CIC to seize the initiative to forge out a long-term strategy for the industry.

"I think the question the CIC can ask itself is has it been able to capitalise on the very substantial public works expenditure, railways, bridges, the cruise terminal, that have gone on in order to improve the industry for the longer term. That's the question I think I would be asking if I was involved today and, if it hasn't done, what can we do whilst that expenditure is still being pumped out. There's still a lot of public expenditure planned and in the pipeline.

"We've gone from a very different circumstance when all this began 10 to 12 years ago with the paucity of expenditure, now to an almost excessive expenditure and are we making good use of that capital to reorganise and restructure the industry? I don't know the answer but I would be saying that's the sort of question for the industry going forward."

《築目》專訪簡基富先生

簡基富先生是一位熟悉行業全景的資深人士。任職太古地產主席的時候，他負責香港的重要發展項目。作為香港地產建設商會主席，他在房地產行業發揮了重大作用。作為一名登山家，他攀登了七大洲的最高峰。而作為建造業議會的創會主席，他為這個新生組織奠定了發展路向。在這次《築目》的訪問中，簡先生回顧了香港建造業的一段關鍵時期，並探索我們今天的位置。

在踏入千禧的那段時間，香港建造業的情境與今天相去甚遠。20 世紀 90 年代時，香港正要趕及在 1997 主權移交前完成香港機場核心計劃的標誌性工程及香港會議展覽中心項目，卻碰上亞洲金融危機，建造業可謂處於危急階段。主要工程項目相繼落成後，建築工人失業率持續上升，同時短樁醜聞震撼整個業界，香港政府隨即成立建造業檢討委員會（建檢會）作出應對。

「我想機場的開幕正正是我們的後建築泡沫時期，當時業內的失業率約在 19%，比其他行業都高，這兩個就是成立建檢會的主要因素。」簡先生說：「當時各自為政的行業當然還有其他各式各樣的問題，但短樁事件和失業問題絕對是主要催化劑，加上工程量大跌使行業嚴重受挫，行業急需重整旗鼓。」

2000 年 4 月，香港特區行政長官委任當時的行政會議成員唐英年先生為建檢會主席，全面檢討建造業的狀況，並建議改善措施。時任太古地產董事總經理的簡先生亦在當時獲邀加入，成為建檢會 16 名成員之一。建檢會於 2001 年 1 月向行政長官提交了題為《建業圖新》的報告書，就建造業各個範疇提出 109 項改善措施，以期提高業界的質素和成本效益。

報告書其中一項主要意見是，儘管建造業是本港經濟的主要支柱之一，但業內界別各自為政，壁壘分明，妨礙行業的長遠發展。報告書總結，應成立一個涵蓋各主要界別的法定統籌機構，以求在市場主導的環境下建立自我規管的文化。

臨時建造業統籌委員會（臨時建統會）在 2001 年 9 月成立，旨在倡導業界進行改革，以及為盡早成立法定業界統籌機構作出準備。簡先生於 2002 年 9 月獲委任為臨時建統會主席。

「行業當時還在發展當中，可謂處於相當艱難的時期。我們經歷了金融危機、短樁事件、禽流感以至後來的非典型肺炎，房地產市場一路下滑，政府開支亦隨機場完工後下降，因此當時大家就有這種『凡事皆可能』的進取態度，嘗試把事情重新推回正軌。其實在某程度上，我想主要是由地鐵項目總監 Russell BLACK 帶領的一些項目發展機構和一兩間私營建築公司開始了非正式的集會討論這些問題。由於私營機構間滾存了一些動力，因此當政府宣布成立建檢會和臨時建統會，即乘勢結集了所需動力，為行業提供一個應對當前挑戰的平台。」

當時簡先生的主要職能是確定法定機構的形式，委任甚麼人及如何委任，機構的管理範圍，機構的角色，如何定期換血以注入新的面孔和新的思維，以及各委員會、專責小組和工作小組的架構等等。而資金就來自當時已有徵款制度的建造業訓練局。

「當我接手建造業議會的時候，作為主席，我的焦點並不在於解決行業的問題，因為有其他比我更有能力的人去處理這些事情，反而是為解決當時行業面臨的主要挑戰訂立一個架構，當然還有就是承接當時的勢頭建立一個可以持續運作的組織。儘管我知道當前存在的挑戰，然而我的焦點不在於那些短期問題，而是著眼於建立一個能夠在我退任後仍然繼續運作的組織。」

「我更專注於所謂的人力資源和行政問題，而不是解決行業所有的問題，最後終於成為了臨時建統會和後來的建造業議會主席。我必須率先處理那些問題，才能使機構穩定下來，為它奠下繼續前進的基礎。」

為達成建立法定機構的目的，《建造業議會條例草案》在 2004 年 2 月首度提交立法會，並於 2006 年 5 月 24 日通過，成為《建造業議會條例》。建造業議會（議會）隨後在 2007 年 2 月 1 日成立，以接管臨時建統會的工作，代表業內各界，共同解決《建業圖新》報告書中識別的各項挑戰。

「所謂的成就正是議會的成立，還有就是今天這個更有凝聚力的行業，至少有一個討論和識別問題的平台。所有問題是否全部得到解決是另一回事。」

香港地產建設商會（商會）是一個主要解決與房地產行業相關問題的行業組織，包括土地政策、規劃問題、樓宇法規、建築、市場營銷和法律問題等，亦是議會其中一個指定的代表機構。簡先生於 2011 年 4 月當選商會主席。

「我在議會服務的時候，的確有為商會成立一個建築小組委員會，因為我覺得有必要更專注於建造業的問題，雖然我們在商會的人通常集中處理土地和規劃方面的事。從早期的臨時建統會開始及至後來的建造業議會，我始終認為必須由客戶主導，因為如果客戶不主導的話就甚麼都不會發生，事實上這也是我獲邀出任主席的原因之一。不是我們不重視行業的其他持分者，但基本上誰出資本，誰就有主導權。」

「因此不管是政府還是私人發展商，客戶必須履行領導的角色。政府的角色易當，可以通過行政手段推動各組織支持議會推行的措施。然而要私營市場執行一套一致性的機制可謂相當困難。」

簡先生指商會已經做了很多事情推動各成員，但商會的角色只能推動，不能強行。各私營機構參與議會的工作的程度均有不同，因此很難在發展商方面獲得一致的意見。

「在支持議會措施方面，私營市場可謂各有千秋。不要忘記相對政府而言，私營機構之間存在十分激烈的競爭。你絕不能忽視這點，因為有人誤以為香港的私營市場競爭不大。我們的土地成本高昂，建築成本節節上升，因此為了保持競爭力，發展商會選擇甚麼需要遵守，甚麼可省則省。」

他說某些行業問題諸如健康和安全等不能一次性解決，需要長期努力去維持。但主要的是現在這個行業如何適應前面的發展並變得更有生產力，以及我們在運用科技提高效率和效能上有多進步。這些都是議會在訂定及至 2025 年的未來框架時需要考慮的。

「於《建業圖新》報告書中提出的部分問題已經解決，而餘下的仍在處理當中。接下來的將是牽連甚廣的政治問題，例如怎樣應對勞動力和培訓、是否容許跨境工作等等。這是一個非常棘手的政治問題。」

「行業正在面對這些壓力。我不知道誰會受益，因為定價合同使承建商無法管理自己的成本而賠錢。由於成本上升，私營市場需要大量撥備，最終影響到地價和樓價。我想現在成本和人手問題的性質已經有別於開始的時候。」

「我想議會將重踏臨時建統會走過的路，就是認清行業當下面對的主要問題。」簡先生指，行業現時面對的問題已不同於《建業圖新》報告書擬備期間所面對的問題。舉例來說，90 年代末至千禧年初，建築工程量嚴重不足，而今天則有大量的工程項目同期進行。「我不得不說，我們必須解決的問題之一是成本和效率，因為我看到行業今天面對的挑戰之一是成本不斷上升。我們已經從成立建檢會、臨時建統會到建造業議會的那段饑荒時期，走到了現在政府推出大量工務工程的饗宴時代。」

他說行業現時面對的壓力和緊張將帶來連鎖效應。其中有正面的如工人工資和收入上升，為社會基層成員帶來了上流作用，更提升了入行的動力。但同時也對行業的長期可持續發展亮起了警報。

「但假如這方面的開支再次完全終止的話，將會發生甚麼事？出任議會主席期間，愈是接近期滿我就愈發關注一個問題，就是怎樣聰明地使用已定下的工務工程撥款，嘗試正面地重組和調整業界結構並應對一些相關的問題。」

簡先生的議會主席任期於 2010 年 2 月屆滿，並由現任主席李承仕先生接任。經過 35 年於太古地產工作，簡先生現在經營自己設於香港的物業發展公司，專注於亞洲各地住宅及商用物業。雖然不再如以往般緊貼行業動向，他仍表示香港建造業現在的蓬勃正好為議會提供了機會，為行業開展一套長期的策略。

「我認為議會甚至行業整體可以問的一個問題，就是有否把握這些龐大工務工程，包括鐵路、橋樑、郵輪碼頭等的支出，為行業帶來長遠的改善。假如我今天仍然參與其中，這就是我會問的問題，假如還未做到的話，在這筆資本開支仍在增長的當下，我們應該做些什麼？還有大筆工務工程開支正在籌備當中。」

「10 至 12 年前我們缺乏這方面的開支，而現在我們面對這筆龐大的開支，我們的處境已經完全不同了。我們有否充分利用該資本去重組和調整行業結構？我不知道答案，但我認為這正是行業向前邁進而將要面對的問題。」

Message from Chairman of Committee on Construction Safety

It is my great honour to be elected as the Chairman of the Committee on Construction Safety (Com-CSY), originally named as Committee on Construction Site Safety (Com-CSS), which was re-branded at the Council meeting held on 6 December 2013. The Com-CSS was renamed with the view to further widen the safety scope in the construction industry.

The objectives of Com-CSY are to review and monitor the safety performance of the construction industry, to review and enhance the mechanism of safety management, to identify and recommend measures for improving the safety performance to the CIC, to promote the adoption of the improvement measures by the industry and to nurture a safety culture for the industry. The scope of the Com-CSY is further widened after its re-structure.

2013 was another fruitful year for the Com-CSS. With the support of the committee members, we published three technical guidelines, five safety alerts and three site housekeeping flyers. One seminar on the use of reduced voltage hand tools in construction sites was held with an overwhelming response. In the year ahead, the Com-CSY will continue to be devoted to improving construction safety.

First of all, since the publication of the *Guidelines on Safety of Lift Shaft Works (Volume 3 – Throughout the Occupation Stage of Building)*, two seminars have been conducted to promote and explain the guidelines. A number of workshops and briefing sessions will be arranged in the upcoming months to raise awareness of the guidelines with various property management companies and safety practitioners.

Secondly, the CIC has co-organised Safety Week with the Development Bureau in May for the last two years. Safety Week 2014 will be held from 26 to 29 May this year with an aim to continue promulgating the "Zero Accident" message to practitioners in the construction industry. It will comprise a Zero Accident Flag Presentation Ceremony with a qigong display by around 2,000 construction frontline personnel, a Construction Safety Week Conference, a Construction Safety Week site visit and the Construction Safety Week Considerate Contractors Site Award Scheme 2013 Award Presentation Ceremony.

CHEUNG Hau-wai
Chairman, Committee on Construction Safety

The Com-CSY will also focus on Repair, Maintenance, Alterations and Additions (RMAA) works reflecting the increase in RMAA-related work. Two new working groups

were formed recently under the Task Force on Work Safety of RMAA Sites to explore ways to improve safe work at height through safety design (new buildings) and possible remedial or rectification works to be taken to enhance work safety measures to prevent falls when carrying out RMAA works (existing buildings). The first meeting for the two working groups was launched in January. It is expected that more concrete recommendations from the working groups will be ready later this year.

I am pleased to announce that Ir Professor Albert CHAN has contributed an article to this first issue of *Aedifice* on the very important issue of "Protecting Construction Workers from Heat Stress".

Last but not the least, I would like to thank all of you for your unfailing support to the Com-CSY. We look forward to meeting you soon at our coming events.

建造安全專責委員會主席的話

我很榮幸獲選為建造安全專責委員會（委員會）（原名工地安全委員會，於 2013 年 12 月 6 日舉行的建造業議會 2013 年第六次會議易名）主席。易名是為了進一步擴大建造業界的安全範圍。

委員會的目標是檢討並監察建造業的安全表現、檢討並改善安全管理機制、找出並向議會建議可提升安全表現的措施、向業界推廣採納改善措施以及建立業界安全文化。在架構重組後，委員會進一步擴大了職權範圍。

2013 年是委員會另一個豐收年。在各成員的通力合作下，我們發表了三份技術指引、五份安全提示和三份工地整理單張。我們舉辦的「在工地使用低電壓的電動工具技術研討會」更獲得熱烈回響。在未來一年，委員會將繼續致力提高工地安全。

首先，自正式發表《升降機槽工程安全指引：第 3 卷—整段樓宇佔用期間》（指引第 3 卷）後，我們已舉辦了兩個研討會，並準備在未來數月內會為各物業管理公司和安全從業者舉辦一系列研討會 / 簡介會，加深他們對指引第 3 卷的認識。

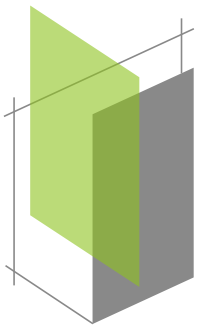
另外，承接過去兩年議會與發展局均聯手在五月合辦的建造業安全周，本年將於 5 月 26 日 5 月 29 日再次舉行，繼續向建造業從業員推廣「零意外」訊息。安全周活動將包括零意外授旗典禮（約 2000 名工地前線人員共同表演氣功）、建造業安全周研討會、建造業安全周工地參觀和建造業安全周—第 20 屆公德地盤嘉許計劃（2013）頒獎典禮。

隨著維修、保養、改建及加建工程的數量日益增加，委員會也開始專注於這方面的工作。委員會轄下的維修、保養、改建及加建工地之工作安全專責小組最近成立了兩個新的工作小組，發掘新的安全設計（新屋宇）提高高空工作安全，及識別可行的修補 / 矯正工作以改善維修、保養、改建及加建工程（現有建築物）的工作安全並防止人身從高處墮下。兩個工作小組均於 2014 年 1 月舉行了首次會議，預計各小組成員將於下半年提出更多的具體建議。

除以上各項外，更令人高興的是我們邀得陳炳泉教授代表委員會於議會第一期期刊發表「建築工人防暑降溫研究」文章。這本萬眾期待的期刊將深入探討行業面臨的各種問題和熱門話題。

最後，我希望藉此機會感謝各位長久以來對建造安全專責委員會的支持。期待在以後的活動與各位見面。

張孝威
建造安全專責委員會 主席



Protecting Construction Workers from Heat Stress

The incidence of heat stress in the construction industry is alarming and has caused a number of verifiable reported deaths. Professor and Interim Dean of the Faculty of Construction and Environment at the Hong Kong Polytechnic University, Professor Albert P.C. CHAN reviews the various anti-heat stress studies, including appropriate work-rest schedule, anti-heat stress clothing and personal cooling systems, that have been conducted to assess their effectiveness in ensuring the health and safety of workers in hot weather.

Construction work is tough and physically demanding. Construction workers have to undertake outdoor work and sometimes in confined spaces with poor ventilation. High temperatures at work can easily lead to exhaustion. Working in these settings during summer puts workers in a vulnerable condition and exposes them to a high risk of heat related incidents such as heat stroke, which has already caused a number of deaths and injuries in Hong Kong (XU and CHAN, 2011). A recent survey revealed that 5% and 23% of construction workers had respectively suffered from heat stroke and experienced signs and symptoms of heat stroke (Hong Kong Confederation of Trade Unions, 2012).

The Hong Kong Government and the industry have expressed concerns of working in hot weather and promulgated a series of fundamental practice notes and guidelines on working in hot weather (Construction Industry Council, 2013; Department of Health, 2010; Labour Department, 2008). However, their recommendations are by and large some "dos and don'ts" and are not based on scientific measurements. The continuing high frequency of heat related incidents in the Hong Kong construction industry calls for better approaches in deriving scientific algorithm to detect impending attacks of heat stress.

Four research projects funded by the Research Grants Council and the Occupational Safety and Health Council respectively have been conducted by the research team of the Hong Kong Polytechnic University (PolyU Research Team) to protect construction workers from heat stress:

1. Experimental research on health and safety measures for working in hot weather (RGC General Research Fund, PolyU 510409). The aim of this project is to develop a set of good practices to ensure health and safety of site personnel working in hot weather.
2. Effectiveness of personal cooling equipment for protecting workers from heat stroke while working in a hot environment (Occupational Safety and Health Council, OSHC/CM/4R/2011-01). The aim of this project is to evaluate the effectiveness of personal cooling equipment for protecting workers from heat stroke.
3. Anti-heat stress clothing for construction workers in hot and humid weather (RGC General Research Fund, PolyU 510711). The aim of this project is to assess the effects of heat stress on construction workers and to the design of proper clothing for construction workers.
4. Developing a personal cooling system (PCS) for combating heat stress in the construction industry (RGC General Research Fund, PolyU 510513). The aim of this project is to assess the cooling performance and applicability of selected commercially available PCSs when applied in the construction industry, and to design a PCS which is suitable for construction workers after taking into consideration the additional requirements of the construction industry.

Project 1

Experimental Research on Health and Safety Measures for Working in Hot Weather (Completed)

Stage I: Heat Tolerance Time

Field studies were conducted in four different construction sites during the Hong Kong summer of July to September 2010. Ten apparently healthy rebar workers aged between 20 and 55 years participated in this study. Exclusion criteria were: flu in the week prior to participation, history of diagnosed major health problem including diabetes, hypertension, cardiovascular disease, neurological problem and regular medication intake. Their participation was on a voluntary basis and participants could withdraw from the experiment at any time as they wished.

When participants carried out the steel bar bending and fixing work, intensity of effort or discomfort felt were self-reported by a Rating of Perceived Exertion (RPE) Scale. Voluntary exhaustion is reached when participants report an RPE of 7 (very hard) or request to stop working, whichever comes first. Such a report implies that workers are physically exhausted and can no longer work. At the same time, physiological and environmental parameters were measured and recorded by a heat stress monitor (QUESTemp°36, Australian) and a telemetry system (K4b2, COSMED, Rome, Italy) respectively *(Figure 1)*.

Figure 1
Apparatus used in the field studies (from left to right: COSMED K4b2, QUESTemp°36 heat stress monitor)

Based upon 281 sets of synchronised meteorological and physiological data collected from bar benders and fixers, physiological, work-related, environmental and personal parameters were measured to construct a heat stress model as shown in *Eq.(1)* (CHAN et al., 2012a). The heat stress model could be further developed to determine the heat tolerance time (HTT) of rebar workers by keeping certain parameters constant. HTT is defined as the duration a rebar worker can work continuously under a given set of meteorological, environmental, and personal parameters without endangering their health and safety.

For example, HTT for a 45 year old rebar worker, who smokes cigarettes and drinks alcohol occasionally, and works continuously at WBGT of 30°C and API of 30 with moderate workload, is 72 minutes (CHAN et al., 2012a).

Eq.(1)

$$RPE = -5.43 + 0.11WBGT + 1.40T + 0.10API + 0.06A - 0.07PBF + 2.28ADH + 0.50SH + 0.14EC + 0.16RE - 0.01RHR$$

where WBGT is wet bulb globe temperature (°C); T is work duration (hour); API is air pollution index; A is age; PBF is percentage of body fat (%); RHR is resting heart rate; ADH is drinking habit ("none"= 0, "occasionally"= 1, "usually"= 2), SH is smoking habit ("none"= 0, "occasionally"= 1, "usually"= 2); EC is energy consumption; and RE is respiratory exchange.

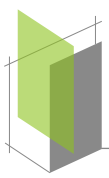
Stage II Optimal Recovery Time

Having computed the maximum duration (HTT) that a rebar worker could work continuously without jeopardising his health, how long the workers should be allowed to recover in hot weather after working to voluntary exhaustion was determined through a second round of field studies. Nineteen rebar workers were invited to perform tasks of fixing and bending steel reinforcement bars on two building construction sites until exhaustion. Criteria for selecting participants are similar to those specified in the first field studies.

Participants were then allowed to recover on site until their physiological conditions returned to the pre-work level or lower. A total of 411 sets of meteorological and physiological data collected over fourteen working days between July and August of 2011 were collated to derive the optimal recovery model. The relationship of rest duration and percentage of recovery was established through this model. It was found that on average a rebar worker could achieve 94% energetic recovery in 40 min; 93% in 35 min; 92% in 30 min; 88% in 25 min; 84% in 20 min; 78% in 15 min; 68% in 10 min; and 58% in 5 min. The longer the rebar workers are allowed to rest, the better the recovery of their strength, although the rate of recovery diminishes as the rest duration prolongs (CHAN et al. 2012b).

Stage III: Work-rest schedule

Monte Carlo simulation technique was used to account for the uncertainties and variations of meteorological and physiological parameters during summer time in Hong Kong (YI and CHAN 2013). On the basis of work-to-exhaustion-then-take-a-rest principle, an optimised work-rest schedule that maximises productive time and at the same time safeguarding the health and safety of rebar workers is developed. An optimised schedule between 8:00 am and 12:00 pm with a 15 min break at 10:00 am; and between 1:00 pm and 5:30 pm with a 30 min break at 3:00 pm is proposed. The findings have been adopted in the latest CIC Guidelines on "Site Safety Measures for Working in Hot Weather" released in April 2013. An additional 15-minute rest period would be introduced for workers during hot summer months (from May to September every year).



Project 2

Effectiveness of Personal Cooling Equipment for Protecting Workers from Heat Stroke while Working in a Hot Environment (Completed)

Stage I : Initial selection

An extensive review of commercially available and commonly used personal cooling systems (PCSs) was investigated for the initial selection. Reference was further made to the results of the laboratory study being conducted by the Kansas State University commissioned by the Occupational Safety and Health Council (OSHC) of Hong Kong for the selection of personal cooling equipment. Two kinds of cooling vests utilising frozen gel were identified for further on-site qualitative comfort and usability assessments.

Stage II : Wear trial

Two kinds of cooling vests (Vest A and Vest B) were tested during the on-field wear trials. Field studies were conducted in construction, catering and kitchen, horticulture and cleaning, and airport apron service industries, respectively (CHAN et al., 2013a). Workers were asked to rate subjective attributes from a self-administrated questionnaire immediately after each wear trial to collect their subjective responses on the two cooling vests. Results of 12 field studies indicated that most workers in four industries preferred Vest B because it had better thermal comfort, usability, fabric hand (feel), and tactile comfort (CHAN et al., 2013a).

Stage III: Laboratory testing

Vest B *(Figure 2)* was therefore selected for further testing under a climatic chamber quantitatively to assess its effectiveness for protecting workers from heat stroke. Twelve rounds of treadmill running inside the climatic chamber which was set and kept constant at 33°C and 75% relative humidity, Vest B was found to be able to slow down the rates of increase of physiological strain index (PSI) a function of participants' core body temperature and heart rate during exercise/working period by 6.69%; and accelerate the rates of reduction during recovery by 6.82% (CHAN, 2013). The effectiveness of Vest B was further demonstrated by qualitative comfort and usability assessments and quantitative physiological response assessments.

Figure 2
Cooling vest B (from left to right: front view, inside view) (OSHC, 2013)

Stage IV : Application assessment

In order to evaluate the practicality of the cooling vest, questionnaire survey and in-depth interviews were further conducted in four industries over a three-month period from September to November 2013. A total of 232 valid questionnaires were collected and 169 participants accepted our in-depth interviews. A remarkable heat strain alleviation of 20.5% (10.9% in construction, 17.6% in horticulture and cleaning, 31.5% in kitchen and catering, and 22.9% in airport apron service) was achieved by the use of Vest B in four industries. Despite the success of heat strain alleviation, several shortcomings of Vest B were identified, including (1) easily-stained colour, (2) heavy weight, (3) short cooling time, (4) inflexibility that presents a hazard around moving parts, (5) lack of indusrty-specific design, (6) nondurable, and (7) thick fabric with poor permeability.

Project 3

Anti Heat Stress Clothing for Construction Workers in Hot and Humid Weather (On-going)

Stage I : Initial fabric selection

Heat and inappropriate clothing may make workers sweat a lot. Comfort in the hot season depends on the choice of fabrics (AMMER, 2011). Comfort involves heat, moisture and air movement, other subjective factors such as size and fit and aesthetic factors including softness, handle and drape (LI et al., 2004). Clothing should also be able to protect them against the damaging UV rays from the sun (HOFFMANN et al., 2001). Thirty-nine (39) types of fabrics were identified to assess their functional properties such as thermal radiation, air permeability, water vapor permeability and moisture management. Five types of fabrics [i.e, CIC, Coolmax 100% (blue), Nano-tex (green), FSD, HN2] were initially selected based on the test results *(Table 1)*.

	CIC	Coolmax 100% (blue)	Nano-tex (green)	FSD	HN2
Weight per unit area (g/cm2)	187.461	146.402	209.434	185.262	185.194
Thickness (mm)	0.826	0.616	0.864	0.482	0.422
MMT-OMMC	0.507	0.802	0.668	0.856	0.845
Air permeability (KPa.s/m)	0.141	0.064	0.115	1.961	1.714
Water vapour permeability (g/day/h)	600.527	593.132	644.126	530.583	501.84
Thermal conductivity (W/m °C)	0.061	0.055	0.076	0.060	0.050
Contact angle (Front) (°)	0	132.3	115.1	0	0
Contact angle (Back) (°)	0	128.6	130.1	0	0
Abrasion (15000-weight loss) (%)	3.107	0	6.646	0	7.394
Anti-static (×1011) (ohms)	2.760	5.880	1.740	1.770	1.180
UPF rating	45	43	50+	50+	35

Table 1
Test results on some selected fabrics

Stage II : Systematic computational experiment

Based on a professional clothing thermal functional CAD system S-smart, systematic computational experiments were carried out to predict the heat stress levels and thermal comfort performance of different types of fabrics under the working conditions of construction workers *(Figure 3)*. The software simulates thermo-physiological processes of human bodies, transfer of heat and moisture in clothing and dynamic interactions with virtual human wearing clothing in different designs, which give various cover ratios (GUO et al., 2008). Heat conduction, convection and radiation, and the latent heat of various phase changes in clothing materials are involved in heat transfer in clothing (GUO et al., 2008). With the application of the S-smart system, Coolmax 100% (blue) and FSD were identified as the best fabric for T-shirt and trousers respectively. A newly designed uniform with consideration the coverage ratio of human body, tightness, ventilation and industry-specific requirements (e.g., reflective strips) was produced as *(Figure 4)*.

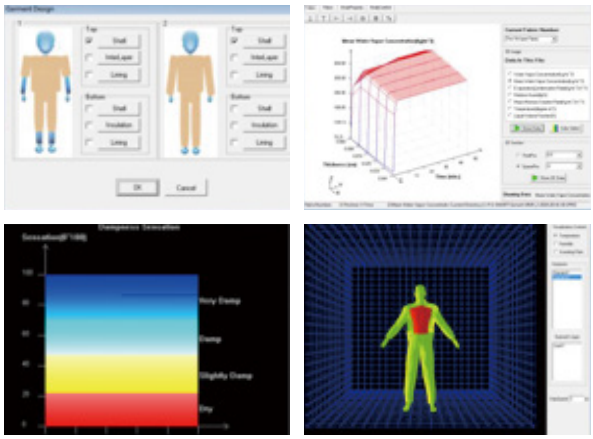
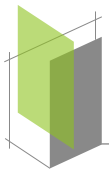


Figure 3
Cooling vest B (from left to right: front view, inside view) (OSHC, 2013)

Figure 4 The newly designed uniform with the fabric of Coolmax 100% (blue) and FSD for T-shirt and trousers respectively (from left to right: front view, back view)

Stage III: Evaluation of the newly designed uniform

To evaluate the effectiveness of the newly designed uniform, both quantitative responses assessment and qualitative comfort and usability assessment will be conducted. Experiments will be carried out inside an environmental chamber to simulate the outdoor hot and humid environments. Each participant will run on a motorised treadmill in a gradually increasing intensity. Comparison between control (a commonly worn uniform) and intervention trials (wearing newly designed uniform) will be made in terms of running distance and speed. Physiological responses will be monitored before, during, and after running. For on-site wear trial studies, construction workers will be invited to wear the newly designed uniform and a commonly worn uniform during their regular working activities on a number of occasions and in different workplaces. Focus group meetings will then be arranged to seek opinions regarding comfort, suitability, practicality and safeness of the clothing of two types of uniform.



Project 4

Developing a Personal Cooling System (PCS) for Combating Heat Stress in the Construction Industry (On-going)

Construction work is tough and demands additional requirements of PCS. PCS should have good cooling performance, clothing permeability, be stain-resistant, light-weight, durable, and easy-to-maintain (PIMENTAL and AVELLINI, 1989). It also needs to be heavy duty and fit well enough with workers' body shape so as not to present a hazard around moving parts, while yet providing flexibility (CHAN et al., 2014). PCS suitable for a sports setting may not necessarily be suitable for construction workplaces. There is a need to develop a tailor-made PCS to protect construction workers from heat related injuries while working in a hot environment.

The research study commenced in January 2014 and is expected to be completed in December 2016. The overall objective is to develop a wearable cooling system that will reduce the effects of heat stress on construction workers. This will be of tremendous value in better safeguarding construction workers' health and safety. Workers will be more comfortable too, regardless of heat stress, with likely beneficial effects on productivity and health.

The proposed study requires both qualitative comfort and usability assessments and quantitative physiological response assessments. It calls for a scientific approach and a multi-disciplinary team to conduct the study and interpret the findings. Team members involved in this application having demonstrable expertise and experience in the fields of occupational safety and health, material sciences, textile sciences, nano technology, and biological and exercise sciences are highly qualified to complete the proposed study with success.

Conclusion

Heat stress can seriously threaten workers' health and safety and is a major occupational hazard in many industries. During summer time, construction workers in Hong Kong need to carry out physically demanding activities in a hostile environment for a prolonged time and hence are subject to a higher risk of heat stress. To ensure the health and safety of site personnel working in hot weather, a series of effective measures, guidelines and codes of practice, and interventions have been developed and reported in this paper. Anti-heat stress clothing and personal cooling system will be designed/ developed for construction workers in hot and humid weather. These anti-heat stress research projects could collectively contribute in reducing the hazardous effects of heat stress to outdoor workers.

About the author

Professor Albert CHAN

Prof. Albert CHAN is a Chartered Builder, Engineer, Project Manager, and Surveyor by profession and has worked in a number of tertiary institutions both in Hong Kong and overseas. His research and teaching interests include project management and project success, construction procurement and relational contracting, construction management and economics, construction health and safety, and construction industry development. Apart from teaching and research, Prof. CHAN has been commissioned by a number of organisations to provide consultancy services in project management and construction health and safety. Prof. CHAN holds an MSc in Construction Management and Economics at the University of Aston in Birmingham and a PhD in Project Management at the University of South Australia. Prof. CHAN was a Founding Director of the Construction Industry Institute, Hong Kong, a joint research institution developed by the industry and academia.

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Acknowledgement

These projects are funded by grants from the Research Grants Council (RGC Project No. PolyU510409, No. PolyU5107/11E, and No. PolyU510513) and the Occupational Safety and Health Council (OSHC Research Grant No. CM/4R/2011-01) of the Hong Kong Special Administrative Region, China. The support from the Hong Kong Housing Authority, Sun Hung Kai Properties Ltd, Yau Lee Construction Co Ltd, China State Construction Engineering (HK) Ltd, the Hong Kong Polytechnic University's Institute of Textiles and Clothing (ITC), the Hong Kong Institute of Education, and the Technological and Higher Education Institute of Hong Kong is deeply appreciated.

建築工人防暑降溫研究

炎熱潮濕的工作環境引致中暑癥狀及事故頻發，嚴重威脅工人的健康和安全。香港理工大學建設及環境學暫任院長及建築及房地產學系教授陳炳泉先生檢閱了一系列防暑降溫的研究項目，例如完善防暑降溫健康安全措施、設計抗高溫高濕地盤工制服、及研發抗熱應激個人冷卻系統等。本文將逐一介紹這些研究項目在保障勞動者健康安全方面的效果。

建築施工多為露天戶外作業，亦時有在通風較差的密閉空間工作，高溫加上高強度的體力勞動加大了夏季施工的危險性。根據相關資料統計，夏季是建築地盤傷亡事故的高發期，地盤工人易出現不同程度的中暑癥狀。最近一項調查顯示百分之五的建築工人曾患中暑，百分之二十三的建築工人曾有不適、幾乎中暑的症狀（香港建築地盤職工總會 2012）。

香港政府部門與行業各界對此予以高度重視，頒布了一系列關於夏季工作的注意事項與基本措施（衛生署 2008；勞工處 2010；香港建造業議會 2013）。然而，目前推行的基本措施缺乏基於科學實驗的研究和臨床參數的定量分析。炎熱工作環境引致本港建造業事故頻發，因此有必要採取科學化的措施及早避免中暑癥狀。

香港理工大學的建築健康及安全研究小組開展了四項關於防止建築工人中暑的研究。此些項目獲香港特別行政區研究資助局優配研究金以及職業安全健康局研究金資助，分別是：

(1) 建築工人在炎熱天氣下工作的健康安全措施研究（研資局優配研究金，項目編號 PolyU 510409）。此項研究為建築工人建立一套科學有效的防暑降溫健康安全措施。
(2) 在炎熱工作環境下使用個人冷卻設備預防中暑的效用研究（香港職業安全健康局，項目編號 OSHC/CM/4R/2011-01）。此項研究旨在評價個人冷卻設備防止工人中暑的有效性。
(3) 抗高溫高濕的建築地盤工制服（研資局優配研究金，項目編號 PolyU 510711）。此研究項目將運用科學的研究方法評估熱環境對建築工人的影響，從而設計適用於建築工人抗高溫高濕的地盤防護衣。
(4) 建築工人抗熱應激個人冷卻系統的研制（研資局優配研究金，項目編號 PolyU 510513）。此項研究將精選已投放市場的個人冷卻系統，評估其應用於建造業的冷卻效果及適用性。在此基礎上，充分考慮建造業的行業需求，研發適用於建築工人的個人冷卻系統。

項目 1

建築工人在炎熱天氣下工作的健康安全措施研究（已完成）

第一階段：工作極限時間

2010 年 7 月至 9 月，研究團隊在四個地盤進行了實地調查，建立並檢驗了高溫作業模型，推算出工作極限時間。十名身體健康、年齡介乎 20 至 55 歲的紮鐵工人參與了地盤實驗。參與者在參與前一周沒有患流感，且無糖尿病、高血壓、心血管疾病、神經系統問題及定期服藥史。參與者純屬自願，並可以隨時退出實驗。

實驗中，參與者進行紮鐵工作，並報告主觀體力感覺，直到體力不支（觀體力感覺達到 7 或主動要求停止）。與此同時，氣象測量儀（QUESTemp°36，澳大利亞）與體能代謝測量儀（K4b2，COSMED，意大利）分 測量記錄工作地點的氣象數據和參與者的生理數據。*圖 1* 顯示了地盤調查中使用的儀器與設備。

圖 1 地盤調查中使用的儀器與設備（從左自右：QUESTemp°36，COSMED K4b2）

研究第一階段根據 281 組氣象數據和生理數據，運用多元回歸法，分析因變量（主觀體力感覺程度）與自變量（年齡、工作時間、濕黑球溫度指數、空氣污染指數、吸煙習慣、飲酒習慣、身體脂肪百分比、靜息心跳率、能量消耗、呼吸強度以及工作種類）之間的關係，建立了高溫作業模型。高溫作業模型如*公式 (1)*所示。高溫作業模型不僅可以反映紮鐵工人的工作狀態，還可以進一步應用於確定紮鐵工人的工作極限時間。工作極限時間即在炎熱天氣下，工人在某些條件下可保持健康安全狀態持續工作的時間。例如一名 45 歲紮鐵工人，平時偶有吸煙、飲酒，他在濕黑球溫度指數為 30°C，空氣污染指數 30 的環境下持續工作的極限時間為 72 分鐘。

公式 (1)

$$RPE = -5.43 + 0.11WBGT + 1.40T + 0.10API + 0.06A - 0.07PBF + 2.28ADH + 0.50SH + 0.14EC + 0.16RE - 0.01RHR$$

註：WBGT 表示濕黑球溫度指數（oC）；T 表示工作時間（小時）；API 表示空氣污染指數；A 表示年齡；PBF 表示身體脂肪百分比（%）；RHR 表示靜息心跳率（次 / 分鐘）；DH 表示飲酒習慣（「0」表示無飲酒習慣，「1」表示偶爾飲酒，「2」表示經常飲酒）；SH 表示吸煙習慣（「0」表示無吸煙習慣，「1」表示偶爾吸煙，「2」表示經常吸煙）；EC 表示能量消耗；RER 表示呼吸強度。

第二階段：最佳休息時間

2011 年 7 月至 8 月，研究團隊在兩個地盤進行了第二輪實地調查，建立了體能恢復模型，推算出適用於紮鐵工人最佳體能恢復時間。十九名符合實驗標準的紮鐵工人參與了第二輪地盤實驗。參與者的篩選標準與第一輪地盤實地調查一致。實驗中，參與者進行紮鐵工作至極限後在遮光處休息，直至參與者的生理熱應力值恢復實驗前正常水平。

第二輪實地調查共收集到 411 組氣象數據和生理數據。研究運用曲線擬合法分析因變量（生理熱應力恢復率）與自變量（休息時間）之間的關係，建立了體能恢復模型。研究第二階段發現，紮鐵工人平均可在 5 分鐘內體能恢復到最初狀態的 58%，10 分鐘升至 68%，15 分鐘升至 78%，20 分鐘升至 84%，25 分鐘升至 88%，30 分鐘升至 92%，35 分鐘升至 93%，40 分鐘升至 94%。休息時間越長，體能恢復的效果越好。

第三階段：作息時間安排

研究第三階段運用蒙特卡洛模擬技術模擬了香港建築地盤氣象數據的參數分布和建築工人生理參數的變化狀態。根據「持續工作至生理極限後進行體能恢復休息」的作息機制，優化後的作息時間安排不僅有助於提升建築業的生產效率，同時保障建築工人的安全與健康。優化後炎熱天氣下建築地盤作息時間安排為：上午 10 點後休息 15 分鐘（濕黑球溫度指數平均為 28.9°C）；下午 2 點 55 分後休息 20 分鐘（濕黑球溫度指數平均為 32.1°C）。此研究不僅建立了一套合理優化作息時間安排的科學方法，更進一步細化及完善了現行的防暑降溫措施。此研究結果已獲建造業議會採納。2013 年 4 月發布的新安全指引中第 5.3 條規定「在酷熱天氣月份（每年 5 至 9 月期間）在上午工作時段設立多 15 分鐘的休息時間予建造業工人」。

項目 2

在炎熱工作環境下使用個人冷卻設備預防中暑的效用研究（已完成）

第一階段：個人冷卻設備初選

為了減低工作時中暑的風險，職業安全健康局選購了一批香港常用的個人冷凍設備，並委託美國堪薩斯州立大學進行冷卻效能的測試。冷凍設備的冷卻效能測試是根據美國材料與試驗協會標準，利用假人的出汗散熱率的標準試驗方法測定個人冷卻設備的冷卻效能。測試篩選了兩款的個人冷凍背心再作進一步的舒適性和實用性的現場評估。

第二階段：冷凍背心試穿

2012 年 8 月至 2013 年 1 月，研究團隊對兩款冷凍背心（A 型及 B 型）的舒適性和實用性進行現場評估。測試對象分別是來自四個行業的前線工友，包括建築，園藝及戶外清潔，機場停機坪，以及餐飲和廚房。參與者在上、下午各試穿一款冷凍背心，每輪穿著實驗結束後即填寫該評估問卷。研究結果表明 B 型冷凍背心具備更好的熱舒適性、可用性、手感和觸感。

第三階段：實驗室測試

在此基礎上，研究團隊進一步對 B 型冷凍背心（如圖 2 所示）緩解熱應激的能力進行測試。2012 年 11 月至 2013 年 4 月，研究團隊於香港理工大學紡織及製衣研究所的氣候模擬實驗室進行了實驗室測試。氣候模擬實驗的環境設置為溫度 33°C 和濕度 75 。參與者在恆溫恆濕的環境下進行兩輪強度遞增的跑步運動（穿著 / 不穿著冷凍背心）。研究結果顯示，穿著冷凍背心有利於緩解人在運動期間生理熱應力指數的增幅（穿著冷凍背心可降低 6.69% 生理熱應力指數的增幅），加速人在休息過程中生理熱應力指數的恢復（穿著冷凍背心可提升 6.82% 生理熱應力指數的增幅）。研究通過定性及定量地研究方法，發現 B 型冷凍背心既具備舒適、使用、實用等性能，又能有效緩解人體熱應激。

圖2
B 型冷凍背心（從左至右：外部，內部）（職業安全健康局 2013）

第四階段：應用評估

2013 年 9 月至 11 月，研究團隊對四個行業的工人進行問卷調查及訪談，目的是評估冷凍背心的有效性和可行性。此次調研共收到 232 份有效問卷，其中 169 名工人參與了深層訪談。調查發現四個行業工人穿著 B 型冷凍背心後工作辛苦程度有明顯減輕，可達 20.5%（建造業為 10.9%，戶外園藝及清潔業為 17.6%，廚房及餐飲業為 31.5%，機場停機坪服務業為 22.9%）。儘管如此，B 型冷凍背心存在著不足之處，包括：(1) 淺色易髒 (2) 質重、欠輕便 (3) 有效涼感時間短暫 (4) 妨礙活動 (5) 缺少反光帶 (6) 不耐用 (7) 布料太厚、透氣性欠佳。

項目 3

抗高溫高濕的建築地盤工制服（進行中）

第一階段：布料初選

吸熱且透氣性能差的工作服使得工人在高溫高濕的環境下大量出汗。工作服布料直接影響工人在炎熱環境下的舒適度（AMMER 2011）。面料透氣、舒適、服帖，具有良好的手感、觸感，且能抗紫外線傷害的工作服，將有效防止工人中暑（HOFFMANN et al. 2001；Li et al. 2004）。通過對三十九種面料的功能特性（如熱輻射性，空氣阻力，水蒸汽滲透性和全面水分管理評價）進行鑒定，研究第一階段篩選出五種吸濕排汗的面料，其代號分別是：CIC、Coolmax 100%（藍色）、Nano-tex（綠色）、FSD、HN2。測試結果如表 1 所示。

	CIC	Coolmax 100%（藍色）	Nano-tex（綠色）	FSD	HN2
單位布重 (g/cm^2)	187.461	146.402	209.434	185.262	185.194
布厚度 (mm)	0.826	0.616	0.864	0.482	0.422
全面水分管理評價（吸濕排汗）	0.507	0.802	0.668	0.856	0.845
空氣阻力 (KPa.s/m)	0.141	0.064	0.115	1.961	1.714
水蒸氣滲透性 (g/day/h)	600.527	593.132	644.126	530.583	501.84
熱傳導率 (W/m °C)	0.061	0.055	0.076	0.060	0.050
接觸角（前）(°)	0	132.3	115.1	0	0
接觸角（後）(°)	0	128.6	130.1	0	0
磨損率（被摩擦 15000 次重量損失率）(%)	3.107	0	6.646	0	7.394
防靜電率 ($\times 10^{11}$)(ohms)	2.760	5.880	1.740	1.770	1.180
抗紫外線係數	45	43	50+	50+	35

表 1
選定面料測試結果

第二階段：系統模擬實驗

研究第二階段通過系統模擬實驗預測了各種面料對建築工人在不同熱環境下工作的熱舒適影響（如*圖 3* 所示）。系統模擬實驗是通過專業服裝熱性能的軟件 S-smart 實現。此軟件能模擬人穿著某種服裝在特定熱環境下工作的情況，包括人體熱生理過程，服裝面料熱交換、水滲透過程，以及模擬人著不同服裝的動態相互作用（Guo et al. 2008）。服裝的熱交換包括熱傳導、熱對流、熱輻射、以及服裝輔料潛在的相變熱傳遞（Guo et al. 2008）。通過 S-smart 軟件的模擬計算，研究第二階段發現 Coolmax 100%（藍色）為最適合 T 恤的面料，FSD 為最適合褲子的面料。在選定面料的基礎上，設計還考慮人體體表覆蓋率、鬆緊度、通氣度、及建築業行業要求（如反光帶）等性能。抗高溫高濕建築地盤工制服的設計樣品如*圖 4* 所示。

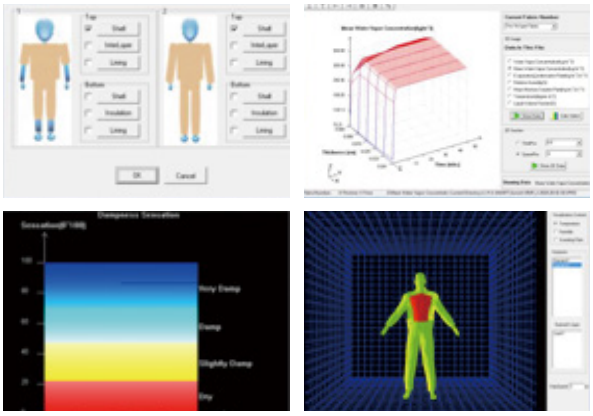

圖 3
系統模擬實驗設計抗高溫高濕建築地盤工制服

圖 4
抗高溫高濕建築地盤工制服樣品（T 恤選用 Coolmax 100% 藍色面料，褲子選用 FSD 面料）（從左至右：正面、反面）

第三階段：新地盤工制服評估

研究第三階段將通過實驗定量評估新設計制服的效用，現場調研定性評價其舒適度、使用性、應用性。實驗將在氣候模擬實驗室展開，實驗環境模擬香港室外的潮濕和炎熱氣候。參與者在此實驗環境下進行兩輪強度遞增的跑步運動（穿著傳統 / 新制工作服），並對比運動測試（穿著 / 不穿著降溫背心）。實驗將對參與者的生理反應進行全過程（實驗前、中、後）監測。在地盤實地調查期間，建築工人將試穿新設計制服及傳統工作服工作一段時間。試穿之後，研究團隊將舉辦焦點小組會議，尋求地盤工人對新設計制服的意見（如舒適度、適用性、實用性、安全性等）。

項目 4

建築工人抗熱應激個人冷卻系統的研制（進行中）

建築施工勞動繁重且體能消耗大，這就要求個人冷卻系統具備良好的冷凍效果、重量輕、耐用、易於保養等特性。同時採用人體工程學的受力傳遞原理，注重弧度貼身設計，在保證承重力度的同時强調背負的穩定性及靈活性。現應用於體育運動的個人冷卻系統未必適合建築地盤施工。因此必須為建築地盤工人量身訂造個人冷卻系統以防止熱應激及中暑。

此研究項目於 2014 年 1 月開始，預計在 2016 年 12 月完成。此項研究將精選已投放市場的個人冷卻系統，評估其應用於建造業的冷卻效果及適用性。在此基礎上，充分考慮建造業的行業需求，研發適用於建築工人的個人冷卻系統。這不僅有助於保障建築工人的安全與健康，同時有助提升建築業工人的生產效率。

研究將採用定性與定量相結合的評估方法。定性評估個人冷卻系統的舒適性及實用性，通過人體生理反應定量評估個人冷卻系統的冷凍效果。研究需要多學科研究方法和跨學科研究團隊。研究團隊集合了建造業健康及安全、材料科學、紡織科學、納米技術、生物及運動科學等多個領域的專家學者，為研發建築工人個人冷卻系統奠定了堅實基礎。

結論

高溫高濕的工作環境已對勞動者的職業健康造成了嚴重的挑戰和威脅。香港夏季炎熱潮濕，建築工人長時間進行高強度的體力勞動，容易出現不同程度的中暑癥狀。為了確保建築工人在炎熱夏季的健康與安全，本文提出了一系列現已研發的措施、指引、工作守則和預防方法。抗高溫高濕建築地盤工制服亦已在研發階段，各項防暑降溫的研究多管齊下，相信能有效降低戶外工人在炎熱天氣下中暑的事故。

致謝

相關研究項目由香港特別行政區研究資助局優配研究金（RGC 項目編號 PolyU510409, PolyU5107/11E, PolyU510513）以及職業安全健康局研究金（OSHC 項目編號 CM/4R/2011-01）資助。研究團隊感謝香港房屋委員會、新鴻基地產發展有限公司、有利建築有限公司、中國建築工程（香港）有限公司、香港理工大學紡織及製衣學系、香港教育學院以及香港高等教育科技教育學院的支持與幫助。

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陳炳泉教授是特許建造師、工程師、營造師及測量師，曾於香港及海外多所著名高等學府工作。陳教授的研究領域包括項目管理，工程採購與承包關系，建築管理及經濟，建造業健康安全，以及建造業發展。研究教學工作之餘，陳教授還為多個組織機構提供項目管理及建築業健康安全方面的咨詢服務。陳教授持有英國阿斯頓大學建築管理及經濟碩士學位和南澳大利亞大學項目管理博士學位。陳教授也是香港建造業研究學會的創辦人。

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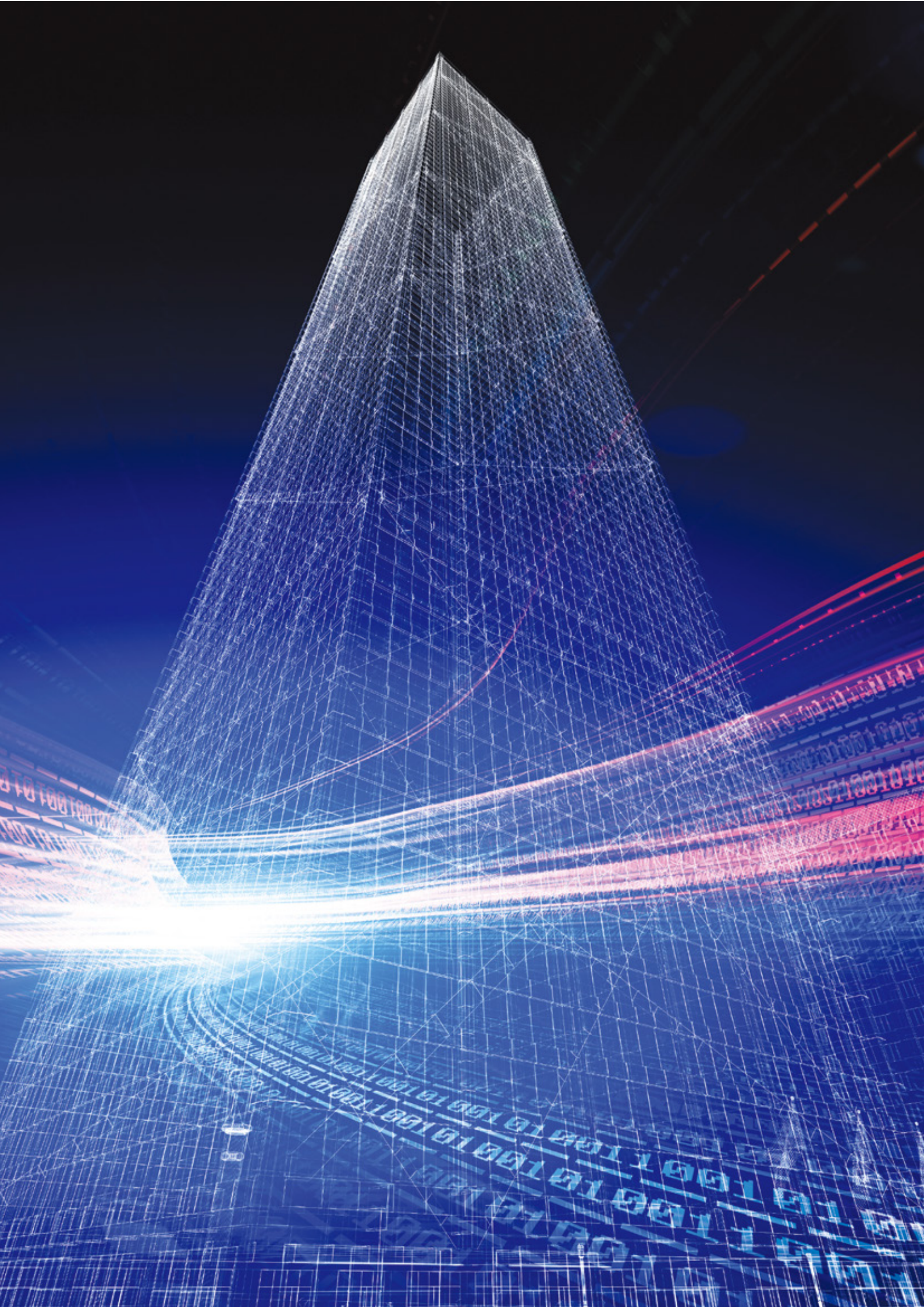


Message from Chairman of Committee on Environment, Innovation and Technology

The Committee on Environment and Technology has been renamed the Committee on Environment, Innovation and Technology since 1 February 2014. The new name reflects the CIC's emphasis on construction innovation and the development of future technology for the sustainability of the industry and the community at large.

The last CIC Conference in November 2013, with the theme "Construction Innovation: Productivity and Technology", focused on the wider adoption of innovative technologies and practices to improve productivity in the construction industry, with an emphasis on building information modelling (BIM). The CIC Conference was well received by a record breaking audience of more than 260 local and overseas delegates and reinforced the insight of the CIC in encouraging more innovation in the construction industry.

The BIM momentum did not stop after the end of the CIC Conference, but will continue. The CIC has designated 2014 as the year of BIM and in April we announced a programme of events that will be organised through the rest of the year to raise the awareness of the industry on this next generation tool for construction stakeholders.

To meet the expectations and needs of our stakeholders in moving the industry forward, members of the Committee on Environment, Innovation and Technology will have another busy year in 2014, exploring new technologies and innovations for the industry. Let us continue to collaborate for the ongoing excellence of our industry.

Kevin POOLE
Chairman,
Committee on Environment, Innovation and Technology

環境、創新及技術專責委員會主席的話

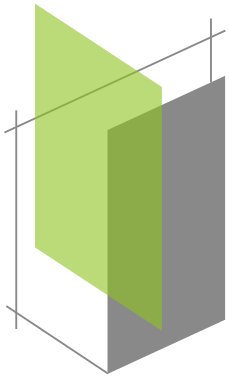
環境及技術委員會自 2014 年 2 月 1 日起，已改稱為環境、創新及技術專責委員會，新名稱反映議會致力推動建造業創新及未來科技的進步，以實現業界和整體社會可持續發展。

於 2013 年 11 月舉辦的建造業議會研討會，主題為「建造業新領域：生產力與科技」，會上集中探討有關廣泛採用創新科技和作業方式以改善建造業生產力，並重點推廣建築資訊模型 (BIM)。研討會吸引了業界踴躍出席，本地及海外參加者人數破記錄地超過 260 人，鞏固了議會鼓勵建造業創新的意念。

雖然建造業議會研討會經已完滿落幕，但建築資訊模型的推廣活動只是剛剛開始。2014 年將會有更多有關建築資訊模型的消息，因為我們正積極籌備一系列的活動，務求提高業界意識及掌握這項建造業持分者的新世代工具。

為實現業界持分者推動行業前進的期望和需要，環境、創新及技術專責委員會各成員在 2014 年將會繼續經歷會務繁忙的一年，探討行業的最新科技和創新發展。期望大家可以攜手努力，追求建造業界的卓越。

潘嘉宏
環境、創新及技術專責委員會 主席



Realising the Promise of BIM in Hong Kong's Construction Industry

Hong Kong's construction industry is facing increasingly difficult decisions on the adoption of building information modelling (BIM). The industry often relies on subjective and ad-hoc approaches, or anecdotal assessments of BIM success and failure. BIM management consultancy bimSCORE puts forward an objective evaluation framework for assessing the maturity and performance of BIM adoption to enable executives and BIM users in Hong Kong to better target their BIM strategies to keep pace with international standards and best practices.

Building information modelling (BIM), the integration of design, construction and operation attribute information (e.g. costs, maintenance data, performance specifications) into the 3D digital geometric representations of design intent and construction specification, is gaining attention in Hong Kong's construction industry, as it is in a growing number of countries and economies around the world *[6]*. Hong Kong's construction industry leaders are increasingly faced with difficult decisions of if, when, where, and how to implement BIM for their projects and enterprises, and are often confronted with an array of inspiring BIM success stories as well as cautionary tales of failures, many of which are anecdotal or backed with scant data. Successful BIM implementation requires holistic and thoughtful decision making in order to justify business investments, identify potential risks, and ensure measurable improvements in project and business performance.

Management scorecards that evaluate management practice through key performance measures have become standard methodologies to assess performance and identify opportunities for improvement in an objective and quantitative manner. Examples of objective evaluation frameworks include Leadership in Energy and Environmental Design (LEED) rating systems, Balanced Scorecard, and Six Sigma techniques. BIM and project management is similar to management in other industries in that it is approached through assessment of key practices and areas of evaluation. The foundation of a balanced scorecard approach could offer an objective, quantitative, and systematic method for evaluating BIM and project performance, providing evidence-based answers to questions such as:

- How can we benchmark our BIM practice to our local marketplace and project client requirements, and swiftly identify action items to fill any potential gaps?
- Which BIM uses are best aligned with our strategic and project goals?
- Is BIM adoption distributed evenly throughout our organisation's teams and projects? If not, which successful projects can be best practice examples for others?
- How does BIM use in our market compare with that in other countries? What can we learn to improve our competitive edge?
- What leading indicators can project managers and project clients use to predict project outcomes, and warn when success is in jeopardy?

BIM technology can accelerate or hinder project success depending on how BIM is integrated with project delivery. By way of analogy, take the case of how powerful travel technology like the space shuttle engages with other travel technology, like standard terrestrial roadways, traditional aircraft, rocket boosters, and the space station. The engagement can be fast and brilliant, or slow and

disruptive. Much as the space shuttle can overwhelm a suburban street or burden traditional aircraft, retarding progress and consuming additional resources, BIM can reduce efficiency when applied inappropriately to conventional project delivery. Yet, integrating BIM with state-of-practice analytical tools and collaborative best practice processes can result in performance improvements that fully realise BIM's potential, much like the space shuttle engaging the space station to further innovative missions of discovery.

Figure 1 A bimSCORE analogy to illustrate the progression of BIM positioning in Hong Kong or other economies, compared to the space shuttle stages of preparation and launch (from Dr. Calvin KAM's presentation at the 2013 Construction Industry Council (CIC) Conference. Image sources, bimSCORE and from left to right: *[1]* www.dailyrecord.co.uk, *[2]* www.planespotters.net, *[3]* NASA, *[4]* 2.bp.blogspot.com

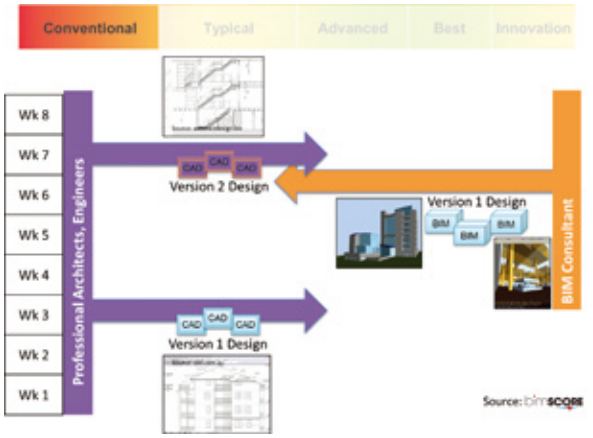


Figure 2 Conventional BIM Practice: BIM in this stage of adoption follows and supports traditional 2D processes and methods of project delivery. The BIM often lags behind 2D documentation, and communication between designers and builders in a "Design-Bid-Build" environment is limited, with little collaborative resolution of issues. Referring to Figure 1 above, the first stage of BIM adoption is much like the space shuttle relying on a very typical mode of transportation, city roadways in transit to its launch.

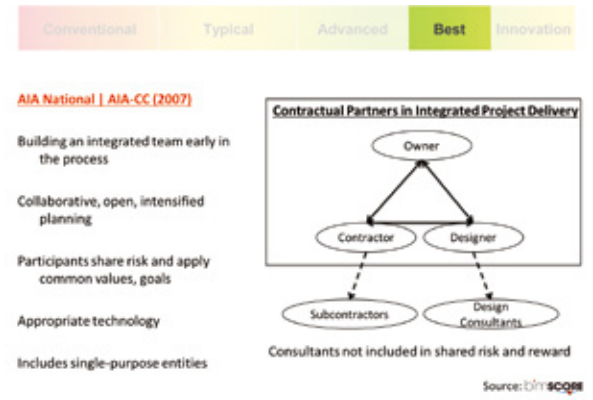


Figure 3 Best BIM Practice: BIM in this stage of adoption, like the space shuttle aligning its power with the launch in *Figure 1*. BIM in this tier would set up performance objectives with shared risks and rewards are agreed to by a number of project stakeholders, incentivising BIM use for early integration and collaboration, and for optimising the design and construction in a shared effort to reduce costs and schedule, and increase facility performance.

Understanding BIM's potential

Before assessing BIM performance and standards of practice, organisations need a solid understanding of the various value propositions of BIM, and how these relate to enterprise or project goals. BIM provides access to data for model-based analyses supporting design and construction, condensing the information needs of many users into an integrated source for easy extraction and analysis throughout a facility's life cycle *[6]*. This drives many of the benefits of BIM, presented here in seven categories identified by the Virtual Design and Construction (VDC) Scorecard Research team at Stanford University's Center for Integrated Facility Engineering (CIFE):

1. Communication: BIM can enable efficient and reliable integration of design and construction information and documentation, reducing drawing errors and omissions, and making decisions and assumptions more informed and transparent. 3D models are also indispensable in visualising and communicating complex coordination issues and sequencing.
2. Facility Performance: BIM can enable efficient exploration of design and construction alternatives to optimise performance in many areas, including construction and operations costs, energy and sustainability, space use and programming, structural analysis, and construction sequencing.
3. Cost: BIM's impact on cost performance is not necessarily due to a particular application or process, but to the benefits accrued through a combination of many different BIM tools and processes applied throughout the lifecycle of a facility. BIM can reduce costs through increases in design and construction productivity, analysis of alternatives to optimise construction and facility performance, and informed decision making from model-based quantity takeoff and estimation tools.
4. Schedule: Gains in design and construction productivity can be difficult to measure, and BIM doesn't necessarily shorten design construction coordination time as compared with more traditional 2D processes. Yet in the same duration as 2D processes, BIM can produce more coordinated and reliable construction drawings, and a more predictable construction schedule driven by BIM quantities.
5. Safety: As a 3D visualisation tool, BIM can enable builders and designers to easily identify and mitigate safety hazards, whether they may exist during construction or during the operation of the facility. Beyond visualisation, model-based analysis tools can be used to automatically check clearances and access requirements to meet safety standards, and

animations can better sequence construction work and optimise site layout to mitigate hazards.

6. Project Delivery: BIM's contribution to project delivery has largely been to increase the efficiency of the design and construction process, and improve the quality of the final deliverables, whether these are drawings, a model, or the facility itself. These benefits are realised through less rework, defects, and design changes, during both design and construction phases. The full value of BIM to project delivery is most often realised in a collaborative environment, where designers, builders, and operators can rely upon shared information, reducing both design and construction changes and rework.
7. Knowledge Management: BIM and supporting tools for information and model exchange allow firms and project teams to maintain consistent processes and standards, and find and develop best practices to optimise workflows. BIMs themselves become a large component of the project knowledgebase, both in terms of exchanging information between project teams and storing commonly used objects and details in libraries for use by builders and operators.

BIM management evaluation framework

Several BIM evaluation frameworks exist in the international and United States (US) BIM marketplaces. Analyses cited throughout this article were performed using bimSCORE, a methodology inspired by the VDC Scorecard research at Stanford University's CIFE (see *Figures 5 through 7*). The VDC Scorecard is an evaluation system, with scores ranging from Conventional Practice (0%-25%) up to Best Practice (75%-90%) and Innovative Practice (90%-100%). As part of a continuing research project since 2009, the VDC Scorecard uses more than 50 measures of BIM/VDC maturity and is backed by more than 140 project case studies from 14 countries *[1]*.

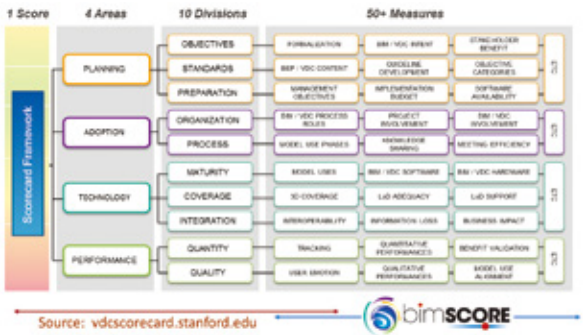


Figure 4 The 4 Areas, 10 Divisions, and 50+ measures of the VDC Scorecard contribute to a detailed score, and more importantly lead to general advice and specific action items for raising practices to higher industry standards of practice.

Results are presented in four primary areas of evaluation:

Planning : addressing objectives, standards, and preparation to meet goals;

Adoption : the organisation and process used in following the plan;

Technology : the maturity, coverage, and integration of tools used to accomplish projects; and finally

Performance : the quantitative and qualitative measures of success for outcomes.

These four areas contribute to the overall score, and more importantly lead to general advice and specific action items for improving BIM management and overall project and industry performance.

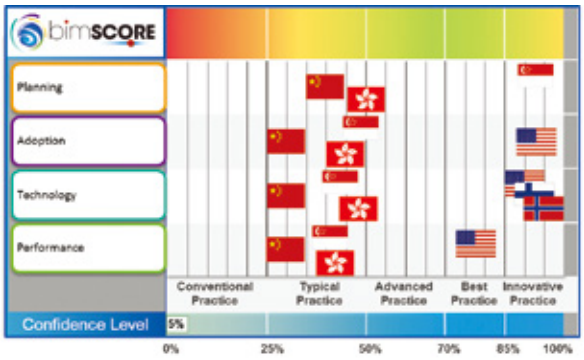


Figure 5 Country to country comparison of selected Asian economies – China, Singapore, and Hong Kong – with countries leading in BIM adoption and maturity, as bimSCORE published in *McGraw Hill Smart Market BIM Report 2014 [5]*. Country comparisons inform public and private owners in setting their BIM expectations and requirements, and assists designers and builders in defining their BIM adoption strategy goals to meet or work within industry standard practice.

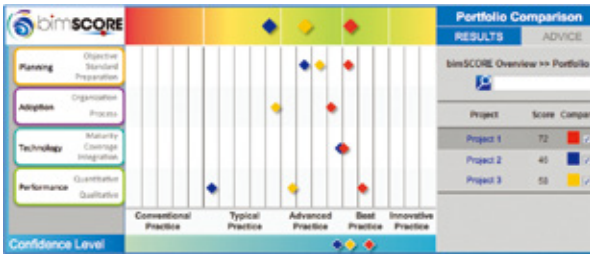


Figure 6 Portfolio-wide dashboard views of evaluations are of value to organisations that design and/or construct many projects across different markets or regions. Tracking performance across an enterprise allows executives and managers to identify areas of strong performance and opportunities to improve, informing decisions on resource allocation, training, and technology adoption.

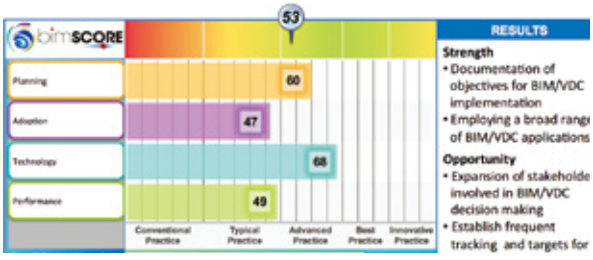


Figure 7 Evaluations of individual projects provide a granular analysis of the maturity and performance of BIM implementation at the project level. These detailed results drive specific action items for seizing opportunities for improvement.

Knowing the BIM market

The Asia-Pacific Economic Cooperation (APEC) Subcommittee on Standards and Conformance recently released its *Start-up Guide, Building Information Modeling*, developed in collaboration with bimSCORE, to assist more than 20 APEC economies with BIM adoption planning. The document identifies key characteristics and action items typical of countries at each stage of BIM adoption (see *Figures 8 and 9* below). Using these ranges of practice, and methods inspired by the VDC Scorecard, international economies can be compared and evaluated to shed light on the relative sophistication of BIM implementation and standards, and challenges encountered, in different construction markets (see *Figure 2* above).

CONVENTIONAL	Minimal BIM adoption, no government policies or support
TYPICAL	Exploring value and implications of implementation for the economy
ADVANCED	Developing support, incentives, and requirements for BIM by government or industry leaders
BEST	Wide adoption of BIM and ready to spread best practices and benefits
INNOVATIOVE	Leading development of new capabilities and extending the value of BIM

Figure 8 Country BIM Adoption Maturity Progression, adapted from the APEC *BIM Start-up Guide* developed in support of the APEC Subcommittee on Standards and Conformance (SCSC) This timeline demonstrates the key characteristics of countries or economies at each stage of BIM adoption *[8]*. Source: bimSCORE.

CONVENTIONAL	– Benchmark current productivity to other economies – Compare the cost of BIM enablement to the cost of maintaining status quo
TYPICAL	– Invest in case studies and pilot projects – Align pilot project targets to strategic goals – Assess each approach and benefit
ADVANCED	– Formalise realistic and enforceable policies at agency and economy-wide levels – Support repeatable and measurable gains
BEST	– Harmonise leadership and grassroots efforts – Encourage with support, rewards, and mandates – Identify and adopt BIM standards and technologies
INNOVATIOVE	– Consider both evolutionary and revolutionary transformation – Establish global strategic partnerships

Figure 9 Top action items to raise the level of BIM practice in a country or economy, adapted from the APEC *BIM Start-up Guide* *[8]*. Source: bimSCORE.

The *2014 McGraw Hill Smart Market Report* on global BIM adoption by contractors *[5]* includes comparison of select Asian economies with global leaders in terms of BIM maturity and sophistication, placing select countries into the overall ranges of practice described above. The figures below further justify and explain the rankings in each of the four areas of evaluation.

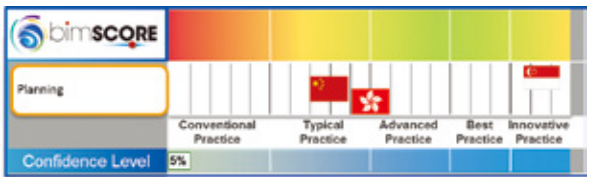


Figure 10 Singapore clearly leads other countries/economies in planning, largely because its Architectural BIM e-Submissions programme is one of the strongest BIM mandates in the world—with well-stated objectives, nationally developed standards and facilitation, and extensive funding to ensure proper preparation and training of the industry *[2]*. The Hong Kong market is lagging behind the leading nations, with few nationally adopted BIM standards, and lack of alignment in public and/or government driven BIM requirements.

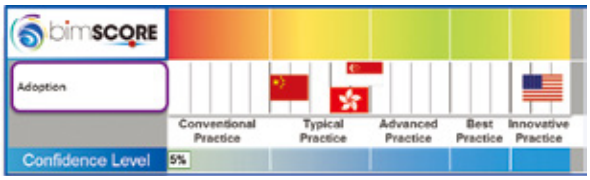


Figure 11 The United States leads in adoption, with over 70% percent of surveyed contractors reporting BIM use in 2012 *[4]*. In the US, progressive national BIM programmes and industry organisations contribute to driving BIM adoption through innovative contract models with shared risks and rewards, BIM guidelines, and standards. The Hong Kong market is similar to other Asian countries in terms of adoption, with few government or owner-driven incentives to adopt BIM, most design and construction organisations in Hong Kong rely on traditional tools and processes.

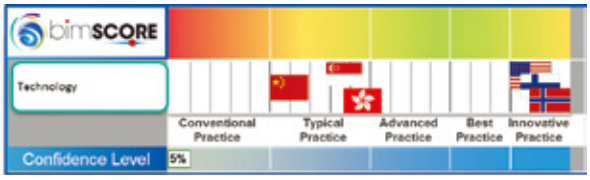


Figure 12 Nordic countries such as Norway and Finland use BIM broadly throughout project teams to leverage a wide range of BIM capabilities, and are strongly supported by national research and development programmes that lead initiatives to adopt open standards, and produce sophisticated and powerful applications such as BIM checkers, BIM servers, and programme requirement management tools. Academic and industry driven BIM research in Hong Kong and other Asian economies is lagging behind leading nations, and organisations and projects are employing BIM on a limited basis.

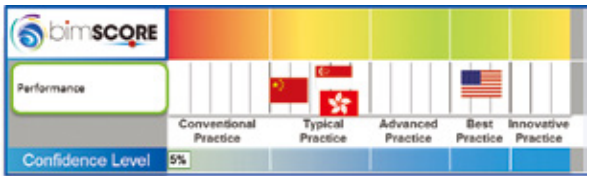


Figure 13 Even in the United States, most organisations don't define objectives for BIM in measurable, performance-oriented terms, and metrics aren't frequently or consistently tracked against targets. Moreover, the lack of clarity in BIM objectives can result in wasted effort, like over-detailing a model or capturing data in formats not useful to facility management systems. General movement toward objective, quantified measures and performance targets in the Hong Kong market will increase the confidence level of management decisions throughout the industry.

BIM and project key performance indicators

In construction markets with high rates of BIM adoption, organisations rely increasingly on management scorecards and key performance indicators (KPI) to target and track performance, predict project outcomes, and identify areas where executive intervention is required. For example, in the US market, designers, builders,

and owners track many metrics to inform their BIM management decisions, and demonstrate the impact of BIM adoption and improved collaboration. Results including those listed below were presented at the 2012 CIFE Summer Program at Stanford University [3]:

Designers/Engineers reported:

- 30% reduction in project schedule (GPLA Structural Designers)
- 33% cost reduction (Sera Architects)
- 328x increase in number of design versions considered (Arup working with CIFE)
- 99.99% reduction in design cycle time (Beck Group working with CIFE)

Design-Builders reported:

- 48% reduction in man hours (Beck Group)
- 30% reduction in construction cost (NCC construction in Sweden)
- 99% reduction in design batch size (Gehry Technologies)
- 85% reduction in effort to track supply chains (Optima)

Builders reported:

- 95% reduction in field rework
- 20% improvement in field productivity
- 0% in scope rework (DPR)

Performance indicators targeted to the specific concerns of a project or enterprise can complement the aforementioned scorecard approaches, as we outlined in another article published by the *Journal of the National Institute of Building Sciences* (USA, BIM Edition) [7]. One such performance indicator is used to track the benefit of BIM-enabled modularisation and prefabrication. The indicator shown below provides executive-level insights into overall prefabrication efforts, where best to expand prefabrication scope, where to deploy additional resources, where the process can be further optimised. Specific metrics include:

- Cost and duration per pre-fabricated component
- Reduction in recordable incidents with shifting labor off-site
- Reduction in defects or punchlist items
- Reduction in material waste (on-site / off-site)
- Reduction in labor costs (on-site / off-site)

Figure 14 A performance indicator for prefabrication, composed of several metrics each with an established target and tracking frequency. These metrics combine to provide an overall score computed in comparison with targets to provide an executive-level indicator of performance for critical factors or processes.

Power of performance evaluations

As we have observed from other global economies, BIM is poised to bring tremendous value with a sweeping impact on the Hong Kong construction industry. Owners can benefit from informed design decisions, predictable construction and better management of lifecycle facility information. Designers and builders will collaborate on productivity using BIM-empowered communications, simulations, and optimisations. Government agencies will automate and more accurately validate and approve submissions using new methods, while mandating BIM delivery and results for their own capital programmes. Gradually, expectations of building occupants and the public-at-large will expand to expect greater efficiencies and environmental quality that are possible through BIM-empowered delivery. These changes are already taking place in other economies.

Conclusion

BIM can be as disruptive as a space shuttle lumbering down a suburban roadway; but BIM can also be as empowering as a vehicle to astronomical accomplishments—— strategic adoption and positioning of BIM is a deciding factor. With tools like the VDC Scorecard and KPI methodology presented in this article, Hong Kong's construction industry professionals can reliably optimise their business decision-making, processes and technologies to:

- Objectively and quantitatively benchmark the maturity of their BIM implementations to proven best practices exhibited within their organisation, and throughout industry;
- Reliably determine performance, if they're meeting their objectives, and where to intervene;
- Identify most successful projects and practices to propagate throughout the firm;
- Establish leading indicators to help project managers and project clients predict project outcomes, and warn when success is in jeopardy; and
- Learn from VDC implementation in other countries, and identify those markets that enjoy a highly sophisticated ecosystem of BIM-enabled organisations

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在香港建造業應用建築資訊模型

香港建造業在是否採用建築資訊模型（BIM）的問題上時常正面臨抉擇。業界往往依賴主觀和即時的想法甚或 BIM 的成敗傳聞作參考因素。有見及此，BIM 管理顧問 bimSCORE 為行政人員和香港的 BIM 用戶提供一個客觀評估框架以衡量 BIM 的成熟程度和表現，協助他們更有效地訂定 BIM 策略，銜接國際標準和最佳作業方式。

BIM 融合設計、建築和操作資訊（如成本、維修數據、表現規格），以三維形式顯示設計原意和施工規格。這種技術在香港建造業漸受觸目，全球使用這種技術的國家和經濟體系亦愈來愈多 *[6]*。香港建造業的領袖在決定是否、何時、何地和如何在項目和企業應用 BIM 的時候，已面對愈來愈多的難題，同時又受到不少有關 BIM 的成敗謠傳所困擾，而這些故事往往只是子虛烏有且缺乏數據支持。要成功實踐 BIM，需要全面和周全的決策，以配合企業投資、識別潛在風險，以及加強項目和績效的表現。

績效計分卡以重點表現來評核管理方式，現已成為評估績效及以客觀和定量方式識別改進機會的標準方法。客觀評估框架的例子，包括「能源與環境先導設計」(LEED) 計分系統、平衡計分卡以及六式碼技術（Six Sigma）。BIM 和項目管理跟其他行業類似，透過重點做法和評估的範圍來進行評核。平衡計分卡方法的基礎，可以提供一個客觀、定量、以及有系統的方法來評估 BIM 和項目績效，並提供數據解答疑問，例如：

- 我們如何規範 BIM 的做法來迎合本地市場及客戶的需求，以及迅速採取行動以填補任何潛在的差距？
- 哪種 BIM 最能配合我們的策略和項目目標？
- 我們組織的團隊和項目是否平均地應用 BIM ？如不，哪個成功項目能為其他項目提供最佳示範？
- 本地市場的 BIM 如何與其他國家的作比較？我們如何學習提升競爭力？
- 項目經理和項目客戶可以用甚麼領先指標來預測項目結果，以及作出風險警報？

BIM 技術可以加速或阻礙項目進行，視乎項目在交付過程中如何應用 BIM。我們可以想像把強勁的交通科技如太空穿梭機配合其他交通技術使用，如路面交通、傳統飛機、火箭推進器和太空站等，得出來的效果可以是快速而卓越，也可以是緩慢而具干擾性的。就像把太空穿梭機放置於郊區街道或傳統飛機上，BIM 在傳統項目中如應用不當，不但降低項目的效率，更會浪費多餘的資源。然而，把 BIM 用於實際分析工具及最佳協作流程的話，即能提升表現，充分發揮 BIM 的潛能，就像太空穿梭機與太空站交接，共同推進探索任務。

圖 1　bimSCORE 以太空穿梭機的升空準備比擬 BIM 在香港或其他經濟體系的定位進展（來自甘嘉恒博士於 2013 年建造業議會研討會的演講材料，圖片來源：bimSCORE，由左至右：*[1]* www.dailyrecord.co.uk *[2]* www.planespotters.net *[3]* 美國太空總署 [4] 2.bp.blogspot.com）

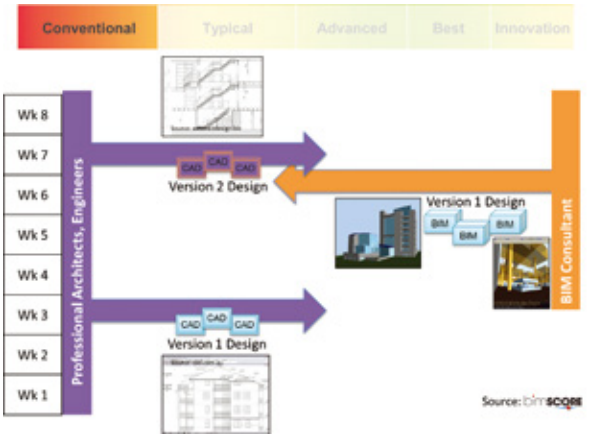

圖 2　傳統 BIM 做法：在這個階段採用 BIM 需依據傳統的二維交付流程和方法，往往落後於二維文檔，設計師和建築師於「設計—招標—建造」環境中的溝通存在限制，鮮有協作解決問題。如圖 *1* 所示，採用 BIM 初期就像依賴傳統的交通工具經由公共交通道路打太空穿梭機運往發射塔。

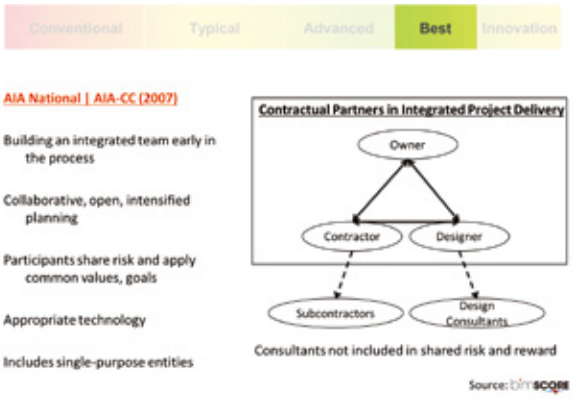

圖 3　最佳 BIM 做法：在這階段採用 BIM 就像*圖 1* 裡，太空穿梭機與發射塔接通。在這階段採用 BIM 訂下不同持份者均同意的績效目標，分享風險與回報，運用 BIM 刺激早期整合和協作，共同優化設計和工程、降低成本、減少程序，並提升設備的表現。

了解建築資訊模型的潛力

在評估 BIM 的表現和工作標準前，組織必須充分了解 BIM 的各項價值主張，以及它們跟企業及項目目標的關連。BIM 為模型為本的分析提供數據支援設計與建築，匯集不同用戶所需的資訊整合為一，以便在設施生命周期當中取用及進行分析 *[6]*。美國史丹福大學綜合設施工程中心（CIFE）的模擬設計與建築（VDC）計分卡研究小組則把 BIM 的優點歸納成以下 7 項：

1. 溝通：BIM 能有效和可靠地整合設計、建築資訊和文件，減少繪圖上的錯漏，提高進行決策和假設時的資訊性和透明度。三維模型在視像化和溝通複雜的協調問題和排序上更是不可或缺。
2. 設施表現：BIM 能有效地協助探索不同的設計和建築選項，令包括建築及運作成本、能源及可持續發展、空間使用和程序、結構分析及建築測序等各方面均能達至最佳表現。
3. 成本：BIM 對性價比的影響，並非單看個別特定的應用程式或程序，而是取決於在設施生命周期中結合應用各種 BIM 工具和流程所產生的效益。BIM 可提升設計和建築的生產力、分析各選項令建築及設施發揮最佳表現，並以模型為本的工程量估算和測量工具協助決策，最終降低成本。
4. 進度表：設計和建築生產力的收穫有時是很難預計的。BIM 未必較傳統的 2D 流程更能縮短設計建築協調的時間。但在相同的時間內，BIM 就能比 2D 流程提供更加協調和可靠的繪圖，以及更準確地預測建築進度。
5. 安全：作為三維視像工具，BIM 可以協助建築商和設計師更容易找到和減少在施工期間或設施投入運作之後出現的安全隱患。除了視像化之外，以模型為本的分析工具可自動進行安全檢查以達到安全標準，而運用動畫更可有效地排列建築工序和地盤布局，確保安全。
6. 項目交付：BIM 減少在設計和建築階段時的重做、缺陷和設計改動，從而提升設計和建築程序的效率，並提高最終交付項目的質素，無論是在繪圖、模型或是設施本身。在設計師、建築商和運營商可以共享訊息的協作環境中最能實踐 BIM 的全部價值，有效減少設計和施工改動和重做的機會。
7. 知識管理：BIM 和其支援工具有助資訊和模型的交流，讓企業和項目團隊保持一致的流程和標準，讓他們尋找和發展最佳的工作流程。BIM 本身成為了項目知識庫的主要部分，方便項目團隊交換資訊，以及儲存建築商和營運商常用的資料和細節等。

BIM 管理評估框架

常見於國際及美國 BIM 市場的評估框架有數款。本文引用的分析都是以 bimSCORE 進行。這是受到美國史丹福大學 CIFE 的 VDC 計分卡研究啟發的一種方法（*圖 5* 至 *7*）。VDC 計分卡是一套評估系統，計分範圍分為「傳統做法」（0%—25%）、「最佳做法」（75%—90%）以及「創新做法」（90%—100%）。作為 2009 年以來持續研究項目的一部分，VDC 計分卡從五十多個項目衡量 BIM/VDC 的成熟程度，並有 14 個國家超過 140 個項目案例支持 *[1]*。

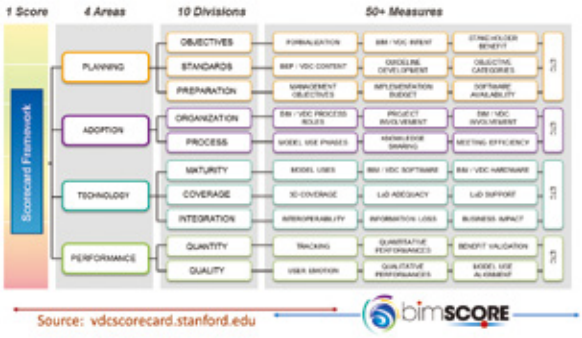

圖 4　VDC 計分卡可詳細分為 4 個範疇、10 個分項、共超過 50 項措施，從中歸納出一般建議和具體的行動項目，把做法提升至更高的業界標準。

評估結果分為四個範疇：

策劃：　認定目標和準則，準備達至目標；

採納：　執行計劃所需採用的組織和流程；

技術：　用於完成項目的工具的成熟度、覆蓋率和整合程度；以及最後的

表現：　達致成果的定量和定性標準。

這四個範疇會計入總分數，更重要的是，可以帶來建議和具體行動方案，提高 BIM 管理及整體項目和行業的表現。

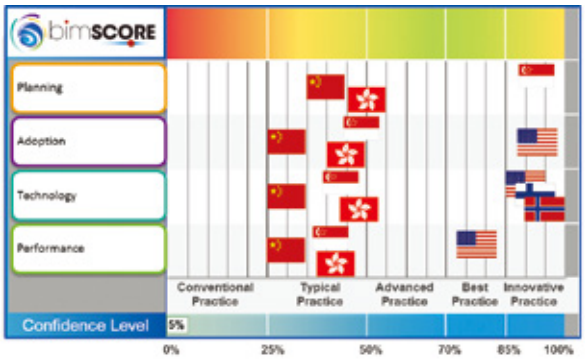

圖 5　bimSCORE 在《McGraw Hill Smart Market BIM Report 2014》*[5]* 發表的數據比較中國、新加坡和香港等亞洲地區經濟體系在 BIM 的採用及成熟程度，讓公共及私營企業可據此訂下對 BIM 的期望和要求，以及協助設計師和建築師訂定採用 BIM 的策略目標，以達致和 / 或遵行行業標準做法。

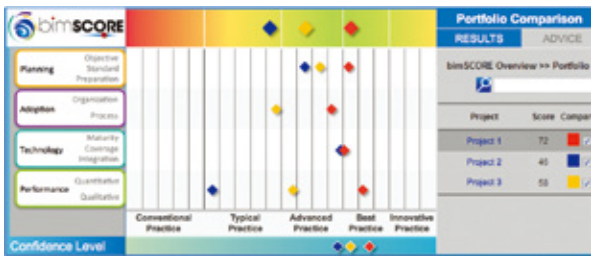

圖 6　組合範圍評估圖表對於在不同地區設計和 / 或建築的組織來說甚具價值。追踪企業的表現可以讓行政和管理人員認清企業的強項和可改善的地方，從而決定資源配置、培訓和技術應用。

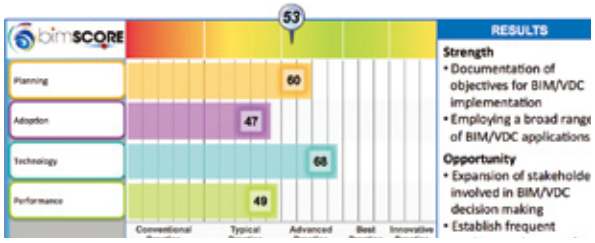

圖 7　通過按項評分詳細展示 BIM 在項目應用上的成熟度和表現，即可據此採取實際行動，抓緊改善的機會。

認識 BIM 市場

亞太經濟合作組織（APEC）的標準及符合性次級委員會（Subcommittee on Standards and Conformance）最近發表與 bimSCORE 合作製訂的《建築資訊模型啟用指南》，協助超過 20 個亞太經合組織成員國採用 BIM 進行策劃。該文件列舉了各國在不同階段採用 BIM 的主要特點和行動項目。（*見圖 8 至圖 9*）。利用這些由 VDC 計分卡啟發的實踐範圍和方法，可以比較和檢討不同建築市場的 BIM 實施情況、標準、以及面對的難題等。(*見上圖 2*)。

傳統	最低限度採用 BIM，欠缺政府和政策上的支持
典型	探索對經濟的價值和影響
進階	政府及業界領袖為 BIM 作出支援、鼓勵和提出要求
最佳	廣泛採用 BIM 並預備推廣和受惠於最佳作業方式
創新	領導開發新功能和擴大 BIM 的價值

圖 8　各國 BIM 採用成熟度進展圖顯示了不同國家和經濟體系在每個 BIM 採用階段中的特點 *[8]*，摘錄自與亞太經合組織標準及符合性次級委員會（SCSC）支持製作的《建築資訊模型啟用指南》。資料來源：bimSCORE.

傳統	– 為其他經濟體系現時的生產力定標 – 比較採用 BIM 或維持現狀的所需成本
典型	– 投資於個案研究和試行項目 – 使試行項目的目標與策略目標配合 – 評估各個方法和好處
進階	– 在機構和各級經濟體系中推行和強制執行政策 – 支援可重複和可衡量的收獲
最佳	– 協調領袖和基層人員的努力 – 支援、獎勵和強制推行 – 識別和採用 BIM 標準和技術
創新	– 考慮逐步演變或徹底改革的轉型方法 – 建立全球策略合作夥伴

圖 9　在不同國家或經濟體系提高 BIM 實踐水平的行動項目。摘錄自《建築資訊模型啟用指南》*[8]*。資料來源：bimSCORE.

《2014 McGraw Hill Smart Market Report》中有關各國承辦商採用 BIM 的部份 *[5]*，比較了幾個亞洲經濟體系的 BIM 成熟程度，並將之放在上文提及的實踐方式總範圍內。以下的圖表將進一步交代和解釋四個評估範疇內的排序。

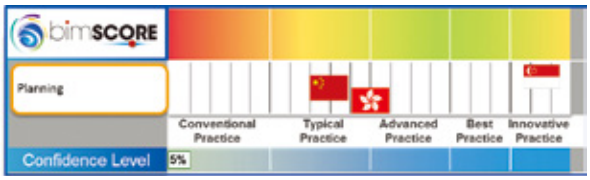

圖 10　新加坡在策劃上明顯較其他國家 / 經濟體系領先，主要是由於其 Architectural BIM e-Submissions 計劃是全球最強的 BIM 指令之一。它具有明確的目標、國家制定的標準和便利措施、以及龐大資金確保業界有適當的準備和培訓 *[2]*。香港的市場則落後於其他領先國家，只有很少全面採用的 BIM 標準，亦欠缺公眾及 / 或政府配合推動的 BIM 條件。

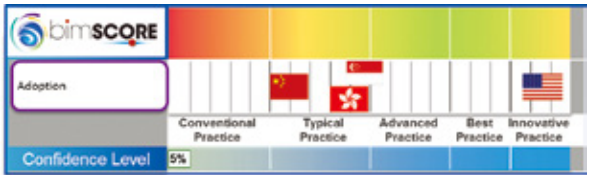

圖 11　美國在採用方面領先，有超過 70% 受訪承辦商在 2012 年採用 BIM [4]。在美國，漸進式的全國 BIM 計劃和行業組織透過創新的合同、共享的風險和回報、BIM 指導方針和標準來推動採用 BIM。香港的市場在採用方面跟其他亞洲地區相似，只有少數政府或業主推動採用 BIM。香港大部分的設計和建築機構都是依賴傳統的工具和程序。

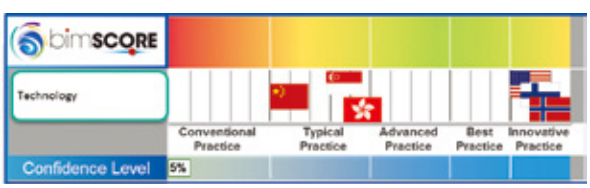

圖 12　北歐國家如挪威和芬蘭的項目團隊廣泛利用 BIM，而且得到國家在研究和開發計劃方面的支持，採用開放準則，從而產生 BIM 審核、BIM 伺服器及項目要求管理工具等。相對而言，香港和其他亞洲經濟體系在學術和行業推動 BIM 研究方面，則較前列國家落後，機構及項目採用 BIM 亦有限。

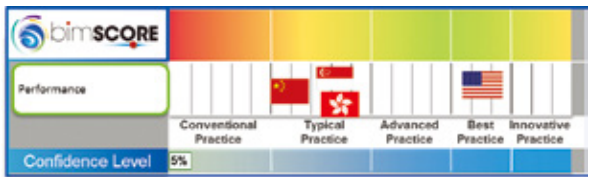

圖 13 即使在美國，大多數機構亦不會為 BIM 訂下可測量及績效為本的目標，而指標亦不是經常或持續地與目標進行比較。同時，缺乏明確的 BIM 目標可能會導致白費努力，例如過分詳細的模型，或取得對設施管理沒用的數據等。在香港市場，向客觀、量化的措施和績效目標的一般進展，已能增加業內管理決策的信心。

BIM 和項目主要表現指標

在 BIM 使用率高的建造業市場裡，組織愈來愈依賴管理計分卡和主要表現指標（KPI）訂立目標、追踪表現、預測成果，和確定需要行政干預的領域。例如在美國的市場，設計師、建築商和業主在進行 BIM 管理決策時檢視許多量度標準，以展示採用 BIM 的影響和加強合作。下列結果在美國史丹福大學 2012 CIFE Summer Program 發表 [3]：

設計師 / 工程師報告：

- 節省項目時間達 30%（GPLA Structural Designers）
- 減少成本達 30%（Sera Architects）
- 可考慮的設計版本增加328倍（Arup與CIFE合作）
- 節省設計周期時間達 99.99%（Beck Group 與 CIFE 合作）

設計—建築商報告：

- 節省工作時數達 48%（Beck Group）
- 節省建築成本達 30%（瑞典 NCC construction）
- 設計修訂工作減少 99%（Gehry Technologies）
- 節省追蹤供應鏈的精力達 85%（Optima）

建築商報告：

- 減少工地重做達 95%
- 提高工地生產力達 20%
- 重訂範圍工作減至 0%

正如我們在建築科學研究所的期刊（美國、BIM 版）上發表的另一篇文章所述，針對項目或企業關注的特定問題的表現指標，可以補充上述計分卡的不足 *[7]*。其中一個表現指標可用於追蹤 BIM 的模組化和預製組件的好處。下文所述的指標為整體預製組件成果提供行政級別的意見，展示如何擴大預製組件的範圍，和在何處部署額外的資源，從而進一步優化流程。具體指標包括：

- 每件預製組件的成本和工期
- 減少場外勞動力的事故紀錄
- 減少缺陷或問題清單項目
- 減少廢料（現場 / 場外）
- 減少工資成本（現場 / 場外）

圖 14 預製組件的績效指標，包含數個指標而每個都有目標預測和追蹤頻率。這些指標結合後，就可以為關鍵因素或流程提供有總體得分比較的行政級別績效指標。

表現評估的力量

觀乎 BIM 在全球其他經濟體系的應用，我們相信 BIM 將為香港建造業帶來重大的價值及廣泛的影響。業主可以在充足的資訊基礎中作出設計決策、預測施工和更好地管理設施生命周期的資訊。設計師和建築師則可利用 BIM 加強通訊、模擬和優化合作以提高產量。政府機構可使用新方法實現自動化、更準確地驗證並審批申請，同時規定於公營資本計劃採用 BIM 交付成果。漸漸地，BIM 將提高住戶和公眾對效率和環境質素的期望，從而成為建築工程的重要技術。這些轉變已經在其他經濟體出現。

結論

BIM 可以是夷平公路的穿梭機，也可以是創造天文學成就的工具，其中的應用策略和定位乃是關鍵因素。香港的建造業專業人士可以使用本文提及的 VDC 計分卡和 KPI 方法，有效地優化他們的業務決策、流程和技術：

- 客觀和定量地衡量所使用的 BIM 的成熟度，在組織和整個行業內實現行之有效的最佳做法；
- 可靠地衡量表現是否達標，以及從何介入；
- 確定最成功的項目和做法，並傳遞至整個公司；
- 訂立領先指標協助項目經理和項目客戶預測成果，並提出預警；及
- 從其他使用 VDC 的國家學習，並了解有哪些國家受惠於 BIM 為行業建構的生態系統。

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RISK?
YES
NO
START

Message from Chairman of Committee on Procurement and Subcontracting

CHEW Tai-chong
Chairman,
Committee on Procurement and Subcontracting

I am pleased to announce the formation of the new Committee on Procurement and Subcontracting (Com-PNS) in February 2014 by merging the former Committee on Procurement and Committee on Subcontracting into a single committee. This new committee, comprising members from across the supply chain, is committed to work with stakeholders to ensure a healthy development of the procurement and subcontracting system in the construction industry of Hong Kong.

Procurement is at the heart of delivering quality, efficient and cost-effective construction. The CIC constantly reviews procurement practices and relating matters that are of interest and significance to the industry. Hong Kong's first cross-sector competition law, *Competition Ordinance* (Cap.619) was passed in June 2012 and a task force was set up under the committee to keep industry stakeholders informed of the development of the new law. A conference was held last year along with a series of publications on the *Competition Ordinance*, helping stakeholders understand the new law and the importance of competition law compliance.

The selection of consultants and contractors also forms a vital part of the procurement process, and to this end, a task force was established to deliberate on the key principles, issues and good practice on the selection of consultants and contractors.

The CIC promotes the use of partnering and equitable risk sharing in construction contracts. The committee issued various publications in the past years aimed at fostering collaborative working and fair risk allocation in construction. Taking the initiative of promoting harmonious working further, the committee formed a Task Force on NEC3 Collaborative Contracts. The task force seeks to help industry stakeholders to understand the practical use of NEC for partnering and collaborative construction with the publication later this year of a frequently-asked-questions booklet on NEC3 contracts. Recently, a task force and a special group were also formed to deliberate the issues relating to the use of employer-procured insurances and on-demand bonds in construction contracts, and the preparation of a fact sheet and an alert on the topics is underway.

On fostering a healthy subcontracting system, a registration scheme named Subcontractor Registration Scheme (SRS) was established to build up a pool of capable and responsible subcontractors with specialised skills and strong professional ethics. A Task Force on Standard Contract Provisions for Domestic Subcontracts was also set up under the committee with an aim of formulating a set of standard contract clauses for stakeholder's reference. This suite of standard forms of domestic subcontract, taking into account existing good practice in the industry, would contain fair, equitable and properly balanced terms for the easy adoption in domestic subcontracts.

The Report on Security of Payment Legislation to Improve Payment Practices in the Construction Industry marked another key accomplishment of the committee. In the report, the CIC reflected the consensus of the industry to put in place legislation in parallel with the implementation of interim administrative measures to improve the cash flow among the construction supply chain and suggested proper resolution of such payment problems. A Working Group on Security of Payment Legislation for the Construction Industry was subsequently formed under the Development Bureau to start the preparatory work towards introducing security of payment legislation in Hong Kong. Further to the release of *Reference Materials for Application of Dispute Resolution in Construction Contracts* in 2013, the committee will continue its work on the Review of the Implementation of the Dispute Resolution Mechanism and Adoption of Dispute Resolution Advisor System in Subcontracts.

I am thankful for all the tremendous efforts our members and stakeholders put in to achieving the above objectives and accomplishments. The new Com-PNS will continue to work hand-in-hand with industry stakeholders to strive for excellence of the construction industry of Hong Kong.

採購及工程分判專責委員會主席的話

我很高興宣布前採購委員會及前工程分判委員會於 2014 年 2 月正式合併成為採購及工程分判專責委員會（委員會）。這個由整個供應鏈各範疇代表組成的全新委員會將繼續與持分者合作，確保香港建造業的採購和分判制度健康發展。

要建造優質、高效和具成本效益的建築物，採購是其中的核心程序，故議會經常檢討行業所關心的採購方式和相關事宜。於 2012 年 6 月通過的《競爭條例》（第 619 章）是香港首條跨行業競爭法，委員會即成立專責小組負責使業內人士了解新法例的最新發展。去年舉行的論壇及一系列關於競爭條例的出版物，均有助持分者了解新法例及遵行競爭法的重要性。

顧問及承建商的選擇也是採購過程的重要一環。為此，我們成立專案小組審議有關選擇顧問及承建商的主要原則、問題和良好方式。

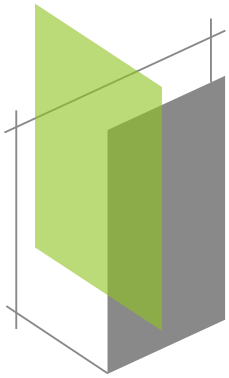
議會鼓勵採用夥伴協作和公平分擔風險的建築合同。委員會在過去數年發表了各類刊物，希望於建造業界推動協同工作和公平分擔風險。為促進進一步和諧合作，委員會又特別成立了新工程合同第三版專責小組，幫助業內人士了解新工程合同第三版於夥伴和協同合作中的實際用途，並將於本年內發表新工程合同第三版常見問題小冊子。最近我們又成立了一個專責小組和一個特別小組，審議關於建築合同中使用聘用人投購保險和來索即付保證書等問題，相關的便覽和提示正在擬備當中。

為培育健康的分判制度，我們成立了一個名為分包商註冊制度（SRS）的登記制度，以建立一支有能力、負責任、兼備專業技能和職業道德的分包商團隊。我們又成立了自選分包合約標準合約條款專責小組，為持分者制訂一套標準合約條款作參考。這套自選分包合約標準合約條款參考了業界現時的良好作業方式，確保條款公平公正且適當平衡，讓自選分包商能輕易採用。

《以付款保障法例改善建造業報告書》亦是委員會的另一項重要成就。議會在報告書中反映了行業的共識，即在立法的同時，實施臨時管理措施提高供應鏈內的現金流，並為付款問題提出了解決方案。發展局隨即成立了建造業付款保障條例專責小組展開於香港引入付款保障條例的前期工作。繼於 2013 年發表《建造合約應用解決爭議方式參考資料》，委員會將繼續其在檢討解決爭議機制實施及分包合約應用解決爭議顧問機制的工作。

我感謝所有成員和持分者為實現上述目標和成就所付出的巨大努力。新的工程分判專責委員會將繼續與業界持分者攜手，為香港建造業打造卓越成果。

周大滄
採購及工程分判專責委員會 主席



Risky Business: Managing project risks with bonds, insurances and other contractual measures

In light of the current trend towards partnering and collaboration, Damon SO and Joyce LEUNG of law firm Hogan Lovells explore management tools which may be adopted to effectively manage risks between employers and contractors the parties as well as examine some recent legal developments.

Managing project risks is one of the key objectives for all parties involved in a construction project. Employers wish to ensure due performance by its contractors of their obligations and obtain security for damages it may suffer in the event of default by the contractor. Contractors on the other hand may face difficulties in providing the security requested by the employer as it may impact on their cash flow or increase the costs of the project.

While on-demand bonds may provide a powerful security measure for employers, given the difficulties that may be caused to contractors, both in terms of procurement and enforcement, employers may wish to consider the adequacy and appropriateness of other forms of security or management tools where appropriate.

Performance Bonds

Performance bonds are a common form of security used by employers to obtain protection in the event of a contractor's default. They are usually provided by a third party (typically by banks or insurance companies) to another party (typically the employer) for payment up to a stated amount and of a limited validity period, such as practical completion or expiry of the defects liability period. It is normally used if there is uncertainty as to the financial capabilities of the contractor or if the employer is unfamiliar with the particular contractor, for example when open tenders are invited.

There are generally two types of performance bonds: an "on-demand" bond and a "default" bond. An on-demand bond imposes a primary obligation on the contractor; the employer may call upon the bond and demand payment from the bondsman without proof of the contractor's breach of its obligation in the underlying contract. In contrast, a default bond imposes a secondary obligation on the bondsman and the employer has to prove that the contractor has breached the underlying contract and caused damage before the bondsman would make payment under the bond.

Given the significant difference in nature and consequence between an "on-demand" and "default" type bond, it is important to distinguish between the two although this has not always proven to be an easy task. In the case of *Wuhan Guoyu Logistics v Emporiki Bank [2012] EWCA Civ 1629*, the High Court considered more than 20 authorities and produced a judgment of more than 93 paragraphs in reaching its conclusion which was, however, overturned by the Court of Appeal. The Court of Appeal emphasised the importance to not only look at the words used in the document but also have regard to the context of the transaction. Recognising the need for certainty, the Court of Appeal held that an instrument "*will almost always be construed as*" an on-demand bond if it "(i) *relates to an underlying transaction between the parties in different jurisdictions,* (ii) *is issued by a bank,* (iii) *contains an undertaking to pay "on demand" (with or without the words "first" and/or "written") and* (iv) *does not contain clauses*

excluding or limiting the defences available to a guarantor". Care should also be taken when making a demand under the bond. The demand should follow the demand wording set out in the bond as closely as possible otherwise the demand may be invalid (see for example *Sea-Cargo Skips AS v State Bank of India [2013] EWHC 177 (Comm)*).

It is generally very difficult to prevent a call on an on-demand bond or harder still, to prevent payment from the bondsman. Attempts have been made in various cases to try to prevent a call on an on-demand bond by seeking an injunction from the Court. Traditionally a call on an on-demand bond may only be restrained only in cases of fraud. Recent authorities suggest that this may be slightly relaxed and if the applicant shows a "*strong case that under the terms of the underlying contract for the performance of which the bond has been provided the beneficiary is not entitled to make a demand on the bond*", an injunction may also be granted (see *Doosan Babcock Ltd v Comercializadora de Equipos y Materiales Mabe Limitada [2013] EWHC 3010 (TCC)* following the decision in *Simon Carves Ltd v Ensus UK Ltd [2011] EWHC 657 (TCC)).* However, it remains difficult to restrain the calling of an on-demand bond which in reality is almost as good as a cash deposit.

An on-demand bond provides an effective and indeed powerful risk management tool for the employer and is usually preferred by the employer given the potential complications of proving loss on a default bond. It provides comfort to the employer that it will have cash security upfront for at least part of its losses suffered without having to wait for the conclusion of what can be a lengthy dispute resolution process. One should note here that calling an on-demand bond does not mean winning an underlying dispute. All the bond does is to ensure that the employer has security (namely cash) upfront pending resolution of a dispute, which may provide useful funds for, for example, carrying out any outstanding or rectification works where the contractor is in breach. The threat of a call upon a bond may also exert pressure on contractors to properly perform their obligations under the contract.

On-demand bonds are however often seen as an onerous requirement by contractors. They are (in most circumstances) expensive to procure and this may often prevent small-sized contractors from meeting the pre-qualification requirements and limit the projects they may tender for. It also often hinders their cash flow and banking facilities. Further, as an on-demand bond may be called without proof of the underlying breach, it may be subject to abuse by some less scrupulous employers. This is especially so as a call on the bond may damage the contractor's commercial and financial reputation, increasing the bank's or insurer's perception of risk which may lead to a reduction of the scope of bonds available to the contractor, or an increase of the price for procuring one or more stringent terms for future projects.

When considering which type of bond should be used, employers should also take into account factors such as cost and time. On-demand bonds are usually more expensive to procure than default bonds, the costs of which may be built into the tender price which may not be desirable to both the contractor and the employer. An on-demand bond may also have a shorter validity period than a default bond with a secondary obligation. The bond amount should be proportionate to the level of risk involved in the project. Bonds with a validity period which extends beyond practical completion or defects liability period may be accompanied by a reduction of the bond amount in stages upon say issuance of the practical completion certificate for the works or different sections of the works.

Parent company guarantee

Parent company guarantees (PCGs) could be a practical alternative to the requirement for a bond, especially if the main concern is that the contractor may go into liquidation and the parent company is a substantial company.

PCGs are a form of contract between the contractor's immediate parent or other holding company and a beneficiary (usually the employer). PCGs operate as a guarantee to ensure its subsidiary's obligations are properly performed and completed. In the event of a default by the subsidiary, the parent would usually under the PCG be obliged to remedy the breach or pay damages for loss suffered by the beneficiary as a result of the breach. In this respect PCGs are similar in nature to a "default" bond such that the parent's liability is secondary to that of its subsidiary and only liable if the contractor fails to perform its obligations.

PCGs can be procured with or without little additional cost to the contractor and the contractor normally readily provides it, as further security or as an alternative to a bond. Another reason why a PCG may be preferred over a bond is that the liability under the PCG will often be co-extensive with the maximum duration of the liability the contractor has under the underlying contract (as opposed to having a fixed expiry date as with most bonds) and cover the contractor's liability for remedying the latent defects.

Beneficiaries should however be careful to guard against PCGs given by a holding company which is merely a shell company and ensure that the PCG is obtained from a company within the group which owns or has control of the substantial assets. Further, given the obligation under the

PCG is a secondary one and only triggered upon the breach of the contractor, employers should ensure that the drafting of the PCG covers insolvency of the contractor, which may not always be a breach in the underlying contract.

Collateral and product warranties

In the Hong Kong environment where multi-layer subcontracting is common, employers may wish to have a direct contractual undertaking (namely a collateral warranty) from for example nominated subcontractors or major subcontractors. This would give the employer more security by allowing it to seek remedies from more than one party (especially where the party is not financially capable of bearing the full liability or even goes into liquidation) should problems arise with the project. It also helps to maintain the relationship between the employer and the main contractor as it bypasses the need for the subcontractors to bring claims against the employer through the main contractor. The employer may also go directly against the defaulting subcontractor without damaging the relationship with the main contractor.

Typically under a collateral warranty provided by a subcontractor to the employer, the subcontractor warrants to the employer that it will comply with its obligations relating to its subcontract works under the main contract. This gives the employer an option to go after either or both of the main contractor and the subcontractor if something goes wrong with the subcontract works in breach of the main contract provisions. Often the employer would like to sort things out directly with the defaulting subcontractor in those circumstances and leave the main contractor out of the dispute so that the main contractor may focus on progressing other works if the project is on-going. In any event the employer may not wish to bring the main contractor into a dispute unnecessarily which would damage the relationship between the employer and the main contractor.

The employer may also manage the risks of defective materials or products by obtaining product warranties from relevant suppliers or manufacturers. Very often there are provisions in the main contract for the main contractor to procure direct warranties on the quality of materials or products from relevant suppliers and manufacturers to the employer in specified terms. The employer generally gets increased or extended protection from those product warranties which normally guarantee due performance of the materials or products for an extended period. A common example is a warranty for waterproofing which may guarantee for example that there is no water leakage for say a five, 10 or 20-year period or a warranty for the due performance of windows or curtain walls. Similar warranties may be obtained for major equipment or other important materials for a particular project from relevant suppliers or manufacturers.

One of the main problems with warranties is to ensure that they are in fact provided. In the absence of express provisions as to consequences, there is usually little incentive for the main contractor to procure subcontractors or suppliers to provide the warranty after it has been awarded the contract and work has commenced. One way to ensure provision of the warranty is for example, as in some contract forms, to make it a condition precedent to interim payment under the contract. Further, care should be taken to see that the warranty is given by a company of substantial size, value and/or reputation; otherwise the risk of it not being practically enforceable should be taken into account.

Retention

Many standard form building contracts will stipulate that the employer will hold a portion of the contract sum up to a specified cap (possibly on trust) for the contractor as a form of security for completion and making good the defects. The percentage of the portion of the contract sum being retained by the employer is usually agreed in advance (normally not exceeding five percent of the total contract sum) and deducted from the interim payments due. Commonly, half of the retention monies are released

at Practical Completion and the balance on a Certificate of Making Good Defects. If a contractor fails to rectify defects, then the retention can be used by the employer towards the cost of rectifying the defects.

If it is intended to create a trust for the retention money, care should be taken of the fact that a trust can only be created if the trust property can be identified. The contract is however usually silent on how the trust money should be kept. It is therefore prudent to specify that the retention money should be kept in a separate trust account rather than left mixed with other monies to ensure a trust is created or can be effectively enforced.

Employers can consider varying the percentage of retention money depending on the size and complexity of the project. The release of the retention monies may also be phased throughout the project. These measures would facilitate the cash flow of the contractors and may ease the pressure on requiring an on-demand bond or a higher bond amount.

Milestone payments and target costs

Under the milestone payment approach, payments are made with reference to the completion of pre-defined "milestones" or "key dates". This approach helps to provide certainty and consistency for payment to the contractor as works progress since payments are made by reference to the project programme. In contrast with the traditional payment method, which payment is determined by making interim assessment, the milestone payment approach helps to avoid discrepancies and disputes over the measurement of work done by the contractor. Employers can draw comfort from being assured of the works reaching critical stages before making commensurate pre-agreed payments.

A target cost contract is a type of contract in which the contractor tenders based on a "target cost" and is reimbursed for the actual cost incurred. NEC Options C and D are popular target cost forms, in use in Hong Kong with the support of the Hong Kong Government. Pilot public works projects have been successfully run on such forms. The MTRC also has its own target cost forms for its projects.

Normally the contractor is required under this form of contract to disclose its accounts on an open book basis for claiming cost reimbursement. If the final cost incurred is below the "target cost", the contractor has a "gain share" to the savings made. On the contrary, the contractor has to "pain share" and contribute to any additional cost incurred above the target. The sharing of gain or pain is subject to a pre-agreed percentage, normally 50:50 and sometimes the gain share may be subject to a cap. The profits (if any) made by the employer and the contractor would therefore depend on how well the parties are able to manage the costs of the project.

As there is an incentive for the contractor to do better than the target cost, this minimises the risk of substantial increase in costs. This incentive would however be reduced if there is a cap on the contractor's gain share. It is also important to set out in detail how the target may be adjusted for any variations or other justifiable events under the contract.

Insurance

Insurance provides effective protection against certain risks such as negligent designs, accidental damage to property or injury to third parties which are common types of risks where insurance may be taken out to cover rather than allocating them to the employer or contractor. The use of insurance is an effective means to avoid putting too much liability on a party for certain risks thereby minimising disputes.

Common types of insurance usually procured in relation to a construction project include:

Professional indemnity insurance – it covers liability for professional negligence such as negligent design and negligent performance of other professional duties, which includes the negligent certification of completion of works by a surveyor or an architect. Usually, professional indemnity insurance is required from the start of the insured party's services in relation to the project up to six or 12 years subsequent to the completion of the project. The reason for having a rather long insurance coverage is due to statutory limitation periods for the bringing of a law suit from the time of breach or damages incurred (as appropriate) as well as the potential existence of latent design defects which may not be detectable long after the completion of the project.

Contractors' All Risks Insurance – this is usually in two parts: (i) public liability section covering personal injury or damage to physical property arising out of the performance of the contract works to third parties; and (ii) contractors' all risks section covering physical damage to the contract works themselves and also to site materials. It is usually maintained in joint names by one of the parties to the building contract. The duration of the all risks insurance policy is usually from the date when the works have started until the date of practical completion of the works. Parties should pay attention to the coverage of the policy (which may not necessarily cover part (ii) as described above) and any exclusion clauses as not all property damage would necessarily be covered

as illustrated in the case of *Axa Insurance UK Plc v. Thermonex Limited [2012] EWHC B10 (Mercantile)* where damage due to faulty design or workmanship on the part of the contractor was excluded and only property which is free of such defective condition but is damaged as a consequence of such defect present in other property would be covered.

Employees' Compensation Insurance – this is required under the *Employees' Compensation Ordinance* (Cap. 282) to cover the employer's liabilities for injuries at work suffered by their employees.

There is currently discussion to broaden the scope of employer-procured insurance policies on the basis that employers may be better placed to secure insurance coverage on better terms and at lower cost than smaller contractors. This would also ensure that all tenders can be considered on a level playing field.

Conclusion

There are a range of risk-allocation measures or management tools as illustrated above which are available for parties in particular employers to choose from and adopt as appropriate according to the risks and demands of particular projects. Whilst on-demand bonds are certainly a powerful form of security, given the potential ramifications on the contractor, employers may consider, and may well benefit from by lowering the cost of the project, using other forms of security more flexibly taking into account different types of construction projects with parties of varying size and financial position involved.

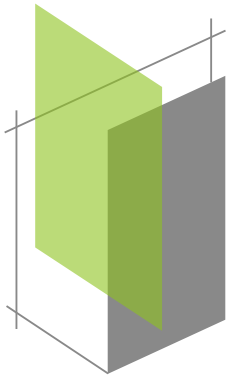
About the authors

Mr. Damon SO

Mr. SO is a Partner with the Projects (Engineering and Construction) Group of the international law firm Hogan Lovells. He initially qualified as a Chartered Civil and Structural Engineer and is a Member of the Hong Kong Institution of Engineers. Since he subsequently also qualified as a solicitor, Mr. SO has undertaken a wide range of construction related legal work and has had occasion to consider many of the issues which typically arise in respect of various construction projects. On the contentious side, he has handled a number of construction related litigation and arbitration proceedings over the years. He is a Fellow of the Hong Kong Institute of Arbitrators and the Chartered Institute of Arbitrators and acts as an arbitrator. He has been involved in advising and drafting construction, joint venture, consultancy and other related contracts for contractors, employers and consultants in respect of a number of building and civil projects.

Ms. Joyce LEUNG

Ms. LEUNG is an associate in the Projects (Engineering and Construction) Group of Hogan Lovells and is qualified in both Hong Kong and England and Wales. Ms. LEUNG has experience in a range of commercial and contentious matters, including litigation and arbitration proceedings, with a particular focus on construction disputes. She has advised on a range of construction legal issues, including matters relating to contract interpretation, defects, delay, variation and payment. She has also undertaken a range of non-contentious construction work, including advising and drafting contracts and other related documentation for employers, contractors, consultants and statutory bodies.



採用履約保證、保險及其他合約措施管理項目風險

現今的趨勢是倡議合夥和協同關係，因此霍金路偉律師行的蘇睿哲和梁曙慰在本文中將著重探討可於僱主與承建商之間有效管理風險的管理工具，並同時審視近期相關的法律發展。

管理項目風險是任何參與建築項目的各方當事人最主要的目標之一。業主希望能夠確保承建商妥善履行義務，並且可以從承建商處取得保證，保證在發生承建商違約的情況時，可就其蒙受的損害獲得賠償。另一方面，提供有關保證則可能會對承建商的現金流產生影響或導致項目成本增加，承建商要滿足業主的要求亦有一定困難。

對業主而言，「來索即付履約保證」（on-demand bond）是一種可以提供強而有力的保障的措施，但鑒於其對承建商在獲取和執行兩方面均可能產生的困難，業主可在適當的情況下考慮其他擔保方式或管理工具是否已能提供充分和合適的保障。

履約保證

「履約保證」是業主為在承建商違約時取得保障而通常使用的一種保證方式。履約保證一般是由第三方（通常是銀行或保險公司）向另一方（通常是業主）出具的保證書，就列明的最高款額在一段有限的有效期（例如直至實際竣工或保修期屆滿等） 作出付款保證，通常會在承建商財務能力不確定或業主對某一承建商並不熟悉（例如在公開投標的邀請中）等情況中使用。

履約保證一般有兩種形式：「來索即付」保證及「違約」保證。來索即付保證對承建商設定一項主要（第一）償付責任；業主可行使保證的權利，要求保證人履行付款責任，無需提出承建商已違反基礎合約責任的證明。相對而言，違約保證對保證人設定一項次級（第二）償付責任，業主須證明承建商已經違反基礎合約的責任並導致損害，然後保證人須依據保證書的規定履行付款責任。

鑒於「來索即付」保證與「違約」保證在性質和後果上的重大差別，將兩者予以區別是非常重要的，雖然這並非易事。在 *Wuhan Guoyu Logistics v Emporiki Bank [2012] EWCA Civ 1629* 一案中，高等法院經考慮 20 多項典據，撰寫超逾 93 段的判詞，然後作出結論，但判決最後仍然被上訴庭推翻。上訴庭強調不單有需要審視文件中使用的字眼，亦有需要考慮相關交易的背景。上訴庭確認有關交易需要確定性後，認為倘若一份文據「(i) 所涉及的基礎合約是由位於不同司法轄區的當事人訂立；(ii) 是由一家銀行出具；(iii) 包含『來索即付』的承諾（不論是否包含『第一』及 / 或『書面』等字眼）；及 (iv) 沒有包含排除或限制保證人可用的抗辯條款」，則該份文據「在差不多所有情況下均應理解為」一份來索即付保證。

在根據一項保證提出付款要求時亦應審慎處理。付款要求應盡量依照保證書所列明的字眼提出，否則有關要求可能無效（請參考 *Sea-Cargo Skips AS v State Bank of India [2013] EWHC 177 (Comm)*）。

一般而言，要阻止受益人行使來索即付保證的權利並非易事，讓保證人免於付款則更加困難。以往案例中當事人會向法庭申請頒發禁制令，阻止業主行使來索即付保證。然而，傳統上，僅僅在涉及欺詐的案件中始可能成功限制來索即付保證的行使。近期的案例顯示這情況可能有輕微的放寬，假若申請人能提出「有力的論據，證明根據為其履行而出具有關保證的基礎合約的條款，有關受益人無權根據該保證提出付款要求」，則法庭會有可能頒發禁制令（請參考 *Doosan Babcock Ltd v Comercializadora de Equipos y Materiales Mabe Limitada [2013] EWHC 3010 (TCC)*；該案跟隨 *Simon Carves Ltd v Ensus UK Ltd [2011] EWHC 657 (TCC)*

的判決作出裁決）。然而，要限制受益人行使與現金存款差不多一樣的來索即付保證的權利依然相當困難。

來索即付保證為業主提供一項有效並且實際上相當強而有力的風險管理工具，而考慮到違約保證須提出損失證明所涉及的潛在繁複要求，一般亦較受業主歡迎。來索即付保證使業主較為安心，最少可就所蒙受的部份損失取得即時的現金保障，無需等待冗長爭議解決程序的結果。值得注意的是，行使來索即付保證的權利，意思並非在一項相關的爭議程序中獲得勝訴。保證所提供的僅僅是確保業主在等待爭議解決的裁決時可以即時獲得某種保障（現金）；這往往可為業主提供有用的資金，以便（例如）就承建商的違約行為進行未完成或補救性的工程。行使來索即付保證的威脅亦可對承建商施加某程度的壓力，令其妥善履行合約下的責任。

然而，對承建商而言，來索即付保證經常被視為一項繁苛的條件。取得這類保證（在大部份情況下）的成本相當高，很多時會令較小型的承建商未能滿足預審資格的要求，限制他們可以競投的項目。通常亦會影響他們的現金周轉及銀行貸款安排的情況。此外，由於來索即付保證可以在不提供相關違約證明的情況下行使，在操守較不嚴格的業主手中可能會出現濫用的情況。鑒於來索即付保證下的付款要求可對承建商的商業及財政聲譽產生負面影響，提高銀行或保險人對該承建商的風險評估，可能導致承建商就將來的項目可獲得的保證的範圍縮減或費用增加及 / 或需接受更嚴格的條款。

在決定採用何種保證時，業主應考慮成本和時間等因素。相對於違約保證，取得來索即付保證的費用通常較高，有關費用可能會計入投標價 ，對承建商及業主雙方均未必有好處。來索即付保證的有效期亦可能會較違約保證下的次級償付責任的有效期為短。保證的金額應合符項目所涉風險水平的比例。保證的有效期如超逾實際竣工或保修期，則可能需在發出整項工程或工程各部份實際竣工的證明書時，按階段遞減保證的金額。

母公司保證

母公司保證是代替保證的實際方法之一，特別是在承建商有可能倒閉而其母公司則是一家規模較大的公司的情況下。

訂立母公司保證的方式是由承建商的直接母公司或其他控股公司與受益人（通常是業主）簽訂保證合約。母公司保證的作用是由保證人提供保證，確保其附屬公司的責任得以妥善的履行及完成。假如附屬公司出現違約的情況，母公司通常須依據有關母公司保證的規定，就有關違約行為作出補救或向受益人支付由於違約行為而蒙受的損害賠償。就此而言，母公司保證在性質上與「違約」保證相似，母公司的付款責任從屬於附屬公司的責任，並且僅須在承建商違反其義務時始須承擔責任。

對承建商而言，母公司保證無需或僅需較小的額外成本，承建商通常會樂意提供，作為保證以外的進一步保障或代替保證的其他保障。母公司保證較受歡迎的另一原因是母公司保證的有效期通常與承建商在基礎合約下的責任的最長期限相同（大部份保證均設有固定的責任屆滿期限）並且涵蓋承建商就潛在建築缺陷所須承擔的責任。

然而，受益人應防範出具母公司保證的控股公司僅僅是一家空殼公司，並應確保出具保證的公司是集團 擁有或控制實質資產的公司。此外，鑒於母公司保證項下的責任僅屬次級償付責任並且僅會在承建商違約的情況下始可執行，業主應確保起草母公司保證時應包括有關承建商破產（在基礎合約中並非時常被視作違約事件處理）的規定。

附帶保證及產品保證

多層的分包安排在香港非常普遍，業主多希望可以從指定分包商或主要分包商處取得直接的合約性承諾（即所謂的「附帶保證」）。此安排會讓業主獲得較大的保障，可以從一個以上的當事方尋求補償（特別是在某一方缺乏足夠的財力承擔所有責任或甚至進行清盤的情況下）。在此安排下，由於分包商無需透過總承建商向業主提出申索，亦有助於維護業主與總承建商之間的關係。業主亦可直接對違約的分包商提出要求，無需損害其與總承建商之間的關係。

在一份由分包商向業主出具的附帶保證中，通常會由分包商向業主作出保證，該分包商會就其在主合約下有關分包工程的義務承擔責任。在相關的分包工程出現問題，違反主合約的規定時，業主可依據上述保證，選擇向總承建商或分包商或同時向兩者追究責任。業主通常

會直接與發生違約的分包商商議解決，讓總承建商無需涉及有關爭議，以便總承建商可繼續專注其他正在進行的工程（倘若有關項目仍在繼續進行中）。無論如何，業主應不會希望將總承建商不必要地牽涉入可能會影響業主與總承建商的關係的爭議之中。

業主亦可從相關的供應商或製造商取得相關的產品保證，藉以管理材料或產品出現瑕疵的風險。主合約通常已包含相關的條款，規定由總承建商促使相關的供應商及製造商就材料或產品質量按照指定的條款向業主提供直接的保證。該等產品保證通常會就某一延展的期限保證材料或產品的適當表現，業主因此可根據該等保證獲得額外或延長的保障。例如，一項防水保證可能會保證在 5 年、10 年或 20 年期 不會發生漏水情況，或保證窗門或幕墻具備適當表現。亦可就某特定工程項目的主要設備或其他重要材料從相關的供應商或製造商取得類似的保證。

此類保證的其中一個主要問題是要確保有關方實際上已提供有關保證。條文上倘若沒有明確關於後果的規定，在獲授合約及工程已經展開後，總承建商通常會缺乏動力促使分包商或供應商提供有關保證。確保有關方提供該等保證的一個方法（例如），類似某些標準合約的方式，在合約中規定該等保證的提供是中期付款的先決條件。此外亦應注意有關保證是由具備相當規模、市值及 / 或信譽的公司提供，否則即有需要考慮該等保證實際上不能執行的風險。

工程保留金

很多標準建造合約均會規定，業主可將最高達某一指定限額的部份合約金額予以保留（或者以信託方式持有），作為承建商完成工程及修復有缺陷工程的抵押。業主可保留的合約金額的百分比通常會預先約定（一般不超過總合約金額的 5%）並會從應付的進度付款中扣除。一般而言，保留金會在實際完工時發放金額的一半，餘額在發出修復缺陷證明書時發放。倘若承建商沒有修復工程缺陷，業主可使用保留金作為修復有關缺陷的成本。
倘若擬設立持有保留金的信託，則應注意任何信託均僅可在信託資產可以識別的條件下始可設立。合約通常沒有關於信託款項應如何保存的規定。因此，審慎的做法是在合約中列明，保留金應存放於獨立的信託戶口中，不與其他款項混淆，以確保能夠就此設立信託或能夠有效執行有關安排。

業主可視乎項目的大小和複雜性，考慮變更保留金的百分比。保留金的發放亦可在整個工程項目中分階段進行。上述措施可為承建商的現金流提供方便並可減輕需要提供來索即付保證或較高保證金額的壓力。

里程碑付款／目標造價

根據里程碑付款的安排，工程款是以事先設定的「里程碑」或「主要工程日期」的完成作為付款參考。鑒於工程款是參考工程項目的進度而支付，此安排有助於承建商按工程進度獲得付款的肯定性和一致性。傳統的付款方式是根據所進行的中期評估然後釐定工程款的支付，相對而言，里程碑付款方式有助於避免由於承建商所完成工程的量度而產生分歧和爭議。業主亦可確保工程達到某決定性的階段然後始支付相應的預先約定的工程款。

根據目標造價合約，承建商按「目標造價」出標而以實際產生的成本獲付工程款。《NEC 工程建設合約》選項 C 及 D 是常用的標準目標造價合約表格，在香港經常採用，並獲香港政府支持。多項試點公共工程項目均以此類標準合同的形式成功開展。港 公司亦有就其工程項目訂立本身的目標造價合約。

此等標準和約條款通常要求承建商以公開賬簿形式就其成本開支的主張披露其賬目的詳情。倘若產生的最終成本金額低於「目標造價」，承建商可就節省的成本開支攤分節省的工程費（gain share）。相反，倘若超出目標，則承建商須分擔超出目標的額外費用（pain share）。節省或超支工程費的分攤均按預先設定的百分比進行，通常是 50:50 的比例，節省工程費的分享有時會有最高限額的規定。業主和承建商可獲得的利潤（如有）因此會視乎雙方管理項目費用的能力。

由於存在誘因讓承建商盡力達到較目標造價更佳的成績，可將重大增加成本的風險減低。然而，倘若承建商可分享節省工程費的數額設有上限，則上述誘因的效力亦會減弱。亦應注意有需要在合約中詳細列明有關目標可以在什麼情況變更或發生其他合理的事件時可以如何予以調整。

保險

對於某些一般可以投購保險的風險，例如設計疏忽、意外造成的財產損害或第三方人身傷害等，保險可以提供有效的保障，相關風險無需有業主或承建商承擔。使用保險可有效避免將某些風險的責任過分集中地由某一方當事人承擔，從而減少發生爭議的機會。

一般建築項目投購保險類別包括：

專業責任保險 — 保障的範圍包括專業疏忽的責任，例如設計上的疏忽、疏忽履行其他專業責任等，包括測量師或建築師在發出竣工證明書時涉及的疏忽行為。一般而言，專業責任保險通常在與工程項目有關的受保方服務開始起即需投保，保險的有效期應延至項目竣工後 6 至 12 年。需要較長保險期的原因是提起訴訟的法定時限是由發生違約或損害（按適用的情況而定）的時間起計，此外，潛在的設計缺陷可能僅會在竣工後較長的時間始被發現。

承建商工程全險 — 通常分為兩部份：(i) 公民責任，保障由於工程的執行而對第三者造成的人和人身損傷或財產損壞；及 (ii) 承建商工程全險，保障對工程本身及地盤材料產生的實質損壞。工程全險通常會由建築合約的一方以聯名方式投購。全險保單的有效期通常由工程展開的日期起直至工程

實際竣工的日期止。鑒於工程全險的保障範圍並非必然包括所有財產損壞，各方當事人應注意保單的保障範圍（不一定會包含上述第 (ii) 部份）及除外責任條款的規定，請參考案例 *Axa Insurance UK Plc v. Thermonex Limited [2012] EWHC B10 (Mercantile)* ；在該案中，由於承建商方面的設計錯誤或工藝問題產生的損壞均免除責任，保險的保障範圍僅包括沒有上述瑕疵但由於其他財產存在該等瑕疵而導致損壞的財產。

僱員補償保險 — 這是《僱員補償條例》（香港法例第 282 章）要求投購的保險，保障範圍包括僱主就僱員在工作中蒙受的損傷而須承擔的責任。

目前有討論希望擴大應由業主購買的保險的範圍，理由是相對於規模較小的承建商而言，業主可以較佳的條件和較低的價格購得保險的保障。此安排亦可確保所有投標者均可在公平的競爭基礎上獲得考慮。

結語

上文介紹了一系列風險分配措施或管理工具，可供各當事方（特別是業主）根據個別項目的特殊風險和要求選擇和採用。來索即付保證固然是一項強而有力的保障，但考慮到其對承建商可能產生的影響，業主可考慮採用其他形式的保障，以便更能靈活地適應不同類型建築項目以及不同規模和財政狀況當事人的需要，甚至亦可能會由於項目成本下降而從中獲益。

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蘇睿哲律師

蘇睿哲律師是國際律師事務所霍金路偉律師行項目（工程及建築）部的合夥人。蘇律師在香港擁有特許土木及結構工程師的正式執業資格，為香港工程師學會會員，同時擁有正式律師執業資格，自正式執業以來曾代理廣泛類型與建築相關的法律事務，處理不同類別建築項目經常產生的各類法律問題。在爭訟性事務方面，蘇律師多年來曾處理大量與建築項目有關的仲裁和法院訴訟案件。蘇律師現為英國特許仲裁人學會及香港仲裁司學會資深會士，並出任仲裁人之職。蘇律師曾就大量建築和土木工程項目為承建商、業主和顧問等當事方起草有關建築、合資經營、顧問和其他相關合同及提供法律咨詢。

梁曙慰律師

梁曙慰律師是霍金路偉律師行項目（工程及建築）部的律師，在香港及英國及威爾斯取得律師執業資格，對廣泛系列的商業和爭訟性事務（包括法院訴訟及仲裁程序）擁有豐富經驗，特別專門處理與建築爭議有關的事務。梁律師的經驗包括就各類與建築相關的法律事務（包括合約解釋、工程缺陷、延誤、變更和工程款的支付等），亦曾處理一系列非爭訟性建築項目，包括為業主、承建商、顧問和法定機構起草合約和相關文件及提供法律咨詢。

Message from Chairman of Committee on Productivity and Research

It gives me great pleasure to serve as the Chairman of this newly established Committee on Productivity and Research (Com-PNR). The Construction Industry Council (CIC) has been striving to achieve its vision of promoting unity and excellence of the Hong Kong construction industry. The mission of the Com-PNR aligns with the CIC's strategic focus to lead and transform our industry to become more innovative, productive, and hence more competitive.

With the ramp up in public infrastructure projects in the coming years and abundant overseas opportunities in the region, it is very timely for businesses in the construction industry to improve by restructuring and raising productivity. Our committee is ready to take the lead in pushing the boundaries and bringing the industry's productivity to the next level. We ride the waves of change to anticipate and meet evolving challenges by promoting game-changing initiatives such as modular design and fabrication, building information modelling (BIM), building-construction automation and robotisation, which can significantly reduce the required manpower and time to complete a certain task on site. We shall support their adoption in Hong Kong and shall be constantly on the lookout for the latest technologies to further transform the industry.

More is needed to be done to spur the industry to re-invent our construction processes and ensure that stakeholders in the value chain work in an integrated manner from the beginning of their projects. New measures will also be explored to enhance constructability in the planning stage as well as to encourage builders to use productive technologies and construction methods. A comprehensive construction productivity roadmap is desirable to develop strategies in driving manpower development, enhancing legislative framework, facilitating integration along the value chain, promoting technology adoption and raising industry awareness. Key performance indicators (KPI) will continue to be compiled and updated by the Com-PNR to keep track of the improvements made by the construction industry.

Christopher LEUNG
Chairman, Committee on Productivity and Research

Indeed, the CIC's role goes a long way to being more than just a coordinator. We aim to foster a competent, productive, and sustainable industry. To achieve this goal

we need creative thinking and a strong conviction that innovations, in the form of new ideas, new materials or new products, are the source of productivity growth. In view of this, we shall persist to facilitate research and development for the Hong Kong construction industry by supporting practical research projects and implementing relevant research outcomes.

As domestic high construction demand continues to fuel the industry's restructuring and growth, and globalisation calls for more innovation and increased competitiveness, Hong Kong's construction industry is in the midst of an exciting transformation. This requires the continued strong support of passionate individuals and committed firms as well as the continued pursuit of new innovations geared towards solutions for its realization. Let us continue to work together to meet new challenges and take the steps to propel Hong Kong's construction industry to new heights.

生產力及研究專責委員會主席的話

有幸擔任這個全新的生產力及研究專責委員會（委員會）主席，讓我感到與有榮焉。議會一直致力團結香港建造業以達致精益求精。委員會的使命正是配合議會的重點策略，提高行業生產力以加強競爭力。

面對本地基建項目將在未來數年陸續上馬，海外工作的機會也越來越多，現正是企業的大好時機，通過重組及提升生產力以謀求突破。本委員會已準備好帶領改革，使行業的生產力能更上一層樓。我們乘接變革的勢頭，推廣如模組設計和製造、建築資訊模型（BIM）、施工自動化和機械人施工等能顯著減少各工種所需的人力和時間的革命性措施，以迎接不斷演化的各種挑戰。我們全力支持於香港推行上述措施，同時不斷尋求更多能使行業變革的最新技術。

我們還要做更多的工作，才能創造新的施工流程，確保價值鏈中的各持分者在項目初期便開始共同協作。我們亦會探討新措施以提高在規劃階段的可建築性，並鼓勵建築商使用生產力高的技術和施工方法。我們需要一份全面的建築生產力路線圖以推動人力資源開發、加強立法框架、促進價值鏈整合、推動技術的採用，並提高行業知名度。委員會將繼續編制和更新主要表現指標（KPI）以記錄建造業的進程。

事實上，議會所扮演的絕非僅是協調者的角色。我們的目標是培養競爭力強、生產力高和可持續發展的行業。為了實現這一目標，我們需要的不單是創意思維，更是推動創新的強烈信念，以新意念、新材料和新產品不斷提高生產力。因此，我們將堅持支持實際的研究項目和實施相關的研究成果，繼續促進香港建造業的研究和發展。

本地對建築的大量需求將繼續推動行業的結構調整和增長；而行業亦需要更多的創意和更強的競爭力應對全球化，因此香港建造業正處於激烈的改革當中，極需要持分者的持續投入和各企業的承諾，為達目標而不斷追求創新。讓我們繼續攜手共進迎接新的挑戰，並積極推動香港建造業再創高峰。

梁堅凝
生產力及研究專責委員會 主席

The CIC's Carbon Labelling Scheme for Construction Products

Carbon embodied in a construction facility is an important but much neglected topic. In the absence of an agreed framework to assess carbon emissions of construction materials at the product level, it is difficult to estimate the embodied carbon accurately. The Construction Industry Council (CIC) initiated research into a carbon labelling scheme for construction products by working in collaboration with academia from the University of Hong Kong. The result of this collaborative approach was the framework for the world's first product-based carbon labelling scheme for construction products.

The construction industry accounts for a large amount of greenhouse gas (GHG) emissions due to its enormous consumption of energy and resources. According to the *Hong Kong Ecological Footprint Report 2010* issued by the Worldwide Fund (WWF-Hong Kong), the construction sector was the second largest contributor to Hong Kong's carbon footprint in 2007. In response to the Hong Kong Special Administrative Region (HKSAR) Government's carbon reduction target of reducing the carbon intensity by 50-60% by 2020 on the basis of 2005 levels, the construction industry has an indispensible role to play.

During the life cycle of construction facilities, GHG emissions are associated with the full life cycle stages: resource extraction, construction materials manufacturing, materials transport, on-site construction, operation and maintenance, and demolition. Researchers and industry practitioners normally pay more attention to the emissions released during the user stage of the construction facility or in maintaining the internal environment through processes like heating and cooling, lighting and operation appliances since these stages consume much of the energy over years of usage. However, the carbon embodied in a construction facility should also be considered as it is difficult to mitigate the embodied carbon once the construction is complete (MONAHAN and POWELL, 2011). FIELDSON et al. (2009) also stress that embodied carbon of construction materials shares a significant portion of the building's life cycle emissions (*Figure 1*). Therefore, selecting low carbon materials in the early project stage is highly desirable.

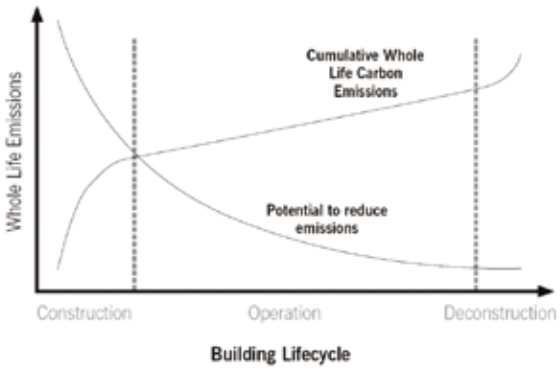

Figure 1 A Potential of reducing whole life emissions during building life cycle (FIELDSON et al., 2009)

In Hong Kong, the recent strong growth in gross construction volume, together with the 10 major infrastructure projects, will continue to drive up the demand for construction services and materials. This makes the availability of low carbon construction materials a pressing demand of the local market. However, Hong Kong does not have an authoritative, independent and publicly acceptable evaluation system providing the benchmark of the locally used construction materials. Industry stakeholders are thus

calling for a recognised evaluating framework indicating the performance of each commonly used construction material.
In view of this, the Construction Industry Council (CIC) initiated a research project in collaboration with the University of Hong Kong to develop a framework for labelling construction products based on the amount of GHGs emitted. After 18 months' study and investigation, the project was completed in late 2012 with the outcome of a Hong Kong-based framework for carbon footprint quantification of six selected construction product categories (cement; structural steel; reinforcing bar; aluminium; glass; and ceramic tiles). This framework determines the scope and GHG sources of the framework, sets out the principles, requirements and guides for the quantification and reporting of the carbon footprint of products (CFP), proposes the benchmarking mechanism for grading each material's CFP, and recommends implementation strategies and plans for the labelling scheme.

Based on the developed framework, the CIC formally launched the Carbon Labelling Scheme for Construction Products in late 2013, which aims to provide the communication of verifiable and accurate information on the carbon footprint of construction products for client bodies, designers, contractors and end users to select 'low carbon' materials. Initially, the scheme covers the three most commonly used construction materials with significant GHG emissions: cement, structural steel and reinforcing bar. Since 2 January 2014, the CIC Carbon Labelling Scheme has been open for application.

It has been more than two years from the start-up of the research project to the launch of the scheme, during which all the involved bodies (the CIC, HKU and other participants from the Government, industry and academia) have made tremendous efforts, and provided suggestions and feedback. This paper presents the work done, summarises current progress and looks into future prospects of the scheme. How the framework turned into reality and the challenges faced during the development and implementation of the scheme are discussed. The CIC's commitment to promoting innovative research to improve the industry is highlighted.

Why the scheme is needed

The fifth assessment report (AR5) was recently released by the Intergovernmental Panel on Climate Change (IPCC) in 2013, sharing the worrying news that GHGs in the atmosphere have reached unprecedented levels. AR5 reports that "the period 1983 to 2012 was likely the warmest 30-year period in the last 1,400 years in the Northern Hemisphere. Arctic sea ice and Antarctic ice sheets are shrinking. Over the period 1901thern Hemibal mean sea level rose by 0.19m" (IPCC, 2013).

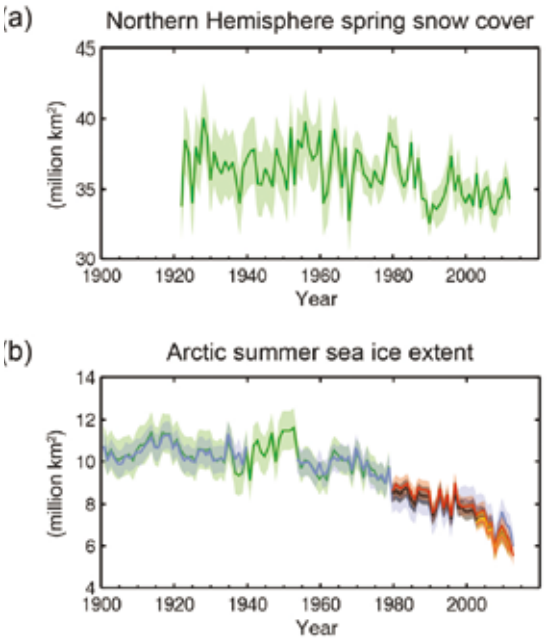

Figure 2 Arctic sea ice extent (left) and global average sea level (right) over 1901 – 2010 (IPCC, 2013)

The Hong Kong Observatory's records reveal that over the past 130 years Hong Kong's temperature has been increasing at a rate of 0.12 degree every decade, while in the recent 30 years the temperature has a faster increase at 0.20 degree per ten years (*Figure 3*). Living in one of the most densely populated metropolitan cities in the world, Hong Kong's citizens have grave concerns about the consequences brought by the increasing anthropogenic GHG emissions.

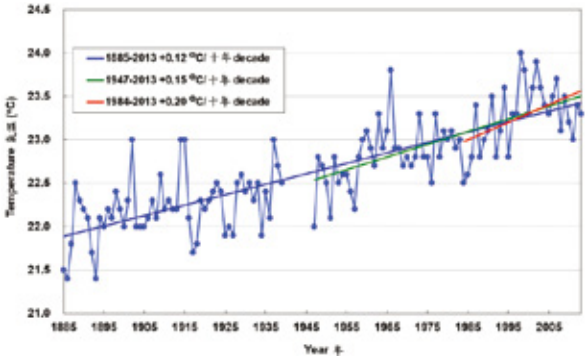

Figure 3 Annual mean temperature recorded at the Hong Kong Observatory over 1885-2013 (HKO, 2014)

Hong Kong's buildings account for about 90% of electricity consumption of the city, and there is great potential to improve energy efficiency and reduce our GHG emissions from the construction and building facilities. It is imperative for the local construction industry to take action to move towards low carbon construction. In recent years, we have been pleased to see that the Hong Kong Building Environmental Assessment Model

(BEAM-Plus) has gained popularity with developers to improve the building energy efficiency and environmental performance. The *Buildings Energy Efficiency Ordinance* (Cap. 610) commenced full operation in September 2012 which requires four major building service installations of new buildings as well as existing buildings undergoing major retrofitting (i.e. air-conditioning, electrical, lift and escalator, and lighting installations) to comply with the energy efficiency standards and requirements specified in the Building Energy Code (GovHK, 2014).

The above mentioned measures focus on the energy efficiency and emissions during the operational stage of the building, the carbon footprint embodied in the construction materials is also significant but neglected.

Previous research revealed that the manufacturing of construction materials alone could contribute to as much as 70% of GHG emissions at the construction stage (SMITH et al., 2002), and 15% of a building's life time energy consumption (HARRIS, 1999). If low carbon materials are selected and used in the design and construction stage, the embodied carbon will be reduced extensively over the whole life cycle of a construction facility. It is thus highly desirable to minimise the GHGs emissions through the prudent selection of low carbon construction products.

Considering the lack of sufficient and uniform market information on low carbon materials and the necessity of an agreed labelling system for the local industry to select low carbon materials, the former Committee on Environment and Technology (Com-ENT) of the CIC commissioned a research team of the University of Hong Kong to conduct the research project on the development of a carbon labelling framework to allow manufacturers to calculate the carbon footprint of their products, and more importantly to identify potential emissions reduction opportunities. A Task Force on Carbon Labelling Framework chaired by Ir Conrad WONG was formed under the Com-ENT to oversee and monitor the progress of the research. The task force consisted of leading professors, engineers, experts and industry leaders, who have provided professional views and constructive comments throughout the research period and implementation stage.

Framework development

To establish the carbon labelling framework, the research was undertaken in four distinct but interrelated stages with the specific research methods designed as presented in *Figure 4*.

Figure 4 Research methods

In the initial stage of the research, a series of semi-structured interviews were conducted with industry practitioners from government, developers, non-government organisations, consultants, contractors and material suppliers, to collect their views on the establishment of such a new carbon labelling scheme. Most of the experts interviewed showed interest in reducing carbon footprint in the industry and considered that a carbon labelling scheme for construction materials would be imperative towards the use of low carbon materials in the construction industry of Hong Kong. Interviewed practitioners agreed that a life cycle GHG emission label should be established for construction materials to indicate their impacts on global climate change. A benchmarking mechanism should be established, with benchmarks set in accordance with both the local scenarios and international standards. To effectively implement the labelling scheme, the commitment and advocacy from the upper stream of the supply chain such as government agencies, clients and developers would be imperative.

The research subsequently proceeded to the classification and selection of materials. A three-tier material classification regime was proposed for the labelling scheme. The schematic classification system for the labelling scheme is first based on the Central Product Classification promulgated by the United Nations Statistical Commission and followed by the material classification of the Inventory of Carbon and Energy (ICE) compiled by the University of Bath in UK. The categories at the product level should be defined in accordance with relevant international standards containing detailed product classification. The specific characteristics of the materials under assessment should then be critically examined for product categorisation. With that, the carbon footprint of materials within the predetermined product category could be benchmarked to facilitate continuous improvement on carbon reduction.

In selecting the materials for the framework development, only materials with significant emissions were considered by adopting the 80/20 rule. A Bills of Quantities (BQ) survey was conducted to estimate the amount of materials used in real life construction projects and their associated carbon footprints. The findings of BQ revealed that six materials, namely (i) cement; (ii) structural steel; (iii) reinforcing bar; (iv) aluminium; (v) glass; and (vi) ceramic tiles are the predominant materials used in Hong Kong in terms of carbon footprint. Other highly ranked materials including concrete, timber, cast iron, brick and block work, will be covered by the carbon labelling scheme in future.

The labelling frameworks for the six selected construction materials were then established which include (i) the definitions of the product categories and relevant terms; (ii) the system boundary and process map for identifying the sources of GHG emissions of the selected products; (iii) CFP assessment tools in MicrosoftTM Excel format for material suppliers to account and report the sources of GHG emissions with relevant emission factors, e.g. for transportation and fuels; and (iv) the benchmarking mechanism.

The carbon labelling framework

Six types of GHGs under the Kyoto Protocol (United Nations, 1997) which impact directly on global warming were covered in the assessment framework, namely, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6), presented as CO2 equivalent (CO2e) in the quantification. The system boundary was set as "cradle-to-site" covering the resource extraction, material manufacturing and product transport until the construction material reaches the border of Hong Kong (see *Figure 5*). Process maps portraying the life cycle production process of the six selected construction materials were compiled and the associated GHG emission sources were identified according to normative references such as ISO 14044: 2006, IPCC 2006, PAS 2050: 2011, etc. The emission sources associated with each of the life cycles, such as fuel consumption, chemical reaction, and fugitive gas, etc. Each assessment framework also included a carbon footprint assessment tool in MicrosoftTM Excel format for material suppliers to prepare their product specific carbon inventories.

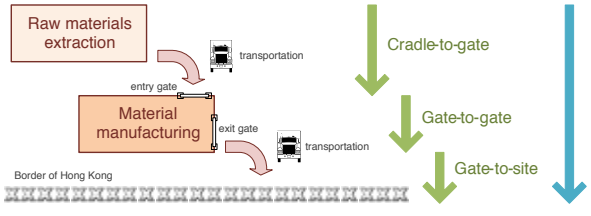

Figure 5 A cradle-to-site system boundary

"The carbon footprint of a product is taken as the carbon emitted during raw material extraction and the manufacturing process up to the point when the finished construction material is delivered to the border of Hong Kong. The decades of life span of construction materials renders it impossible to accurately assess the carbon footprint arising from the use phase and subsequent disposal phase."

When conducting the carbon quantification using the carbon footprint assessment tool, some basic principles are to be followed to ensure the fairness and credibility of each assessment work. According to the life cycle assessment (LCA) methodology provided in ISO 14040:2006 and ISO 14044:2006, the principles are (*Figure 4*):

- Relevance: Select data and methods appropriate to the assessment of the GHG emissions and removals arising from the product system being studied.
- Completeness: Include all GHG emissions and removals that provide a significant contribution to the CFP of the product system being studied.
- Consistency: Apply assumptions, methods and data in the same way throughout the CFP study to arrive at conclusions in accordance with the goal and scope definition.
- Accuracy: Ensure that CFP quantification and communication are accurate, verifiable, relevant and not misleading and that bias and uncertainties are reduced as far as is practical.
- Transparency: Address and document all relevant issues in an open, comprehensive and understandable presentation of information. Disclose any relevant assumptions and make appropriate references to the methodologies and data sources used. Clearly explain any estimates and avoid bias so that the CFP study report faithfully represents what it purports to represent.

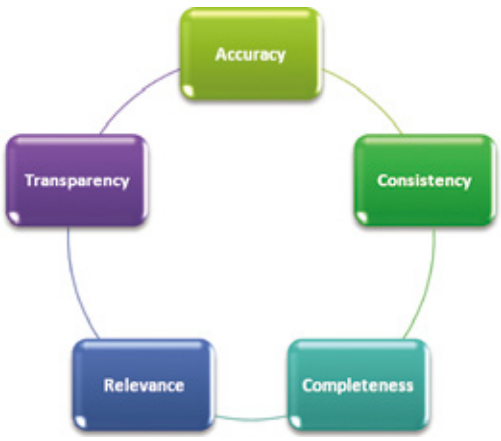

Figure 6 Principles of carbon footprint quantification and reporting

To develop the carbon footprint assessment tools, process maps portraying the life cycle production process of the six selected construction materials were first compiled and the associated GHG emission sources were identified according to normative references such as ISO/TS 14067:2013; ISO 14044:2006, IPCC 2006, and PAS 2050:2011. *Figure 7* shows the process map of cement products. The emission sources associated with each of the life cycles, such as fuel consumption, chemical reaction, and fugitive gas were then identified. Subsequently, the CFP assessment tools in Microsoft™ Excel format were developed for material suppliers to prepare their product specific carbon inventories.

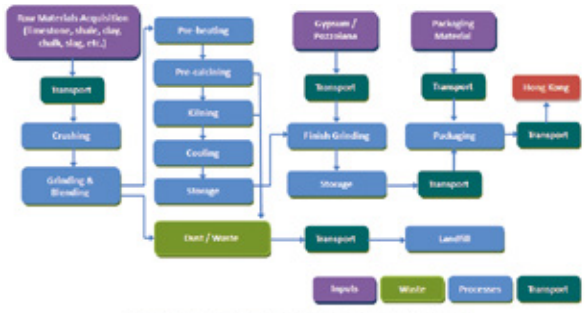

Figure 4. Process Map of Portland Cement Manufacturing[1]

Figure 7 Process map of Portland cement manufacturing

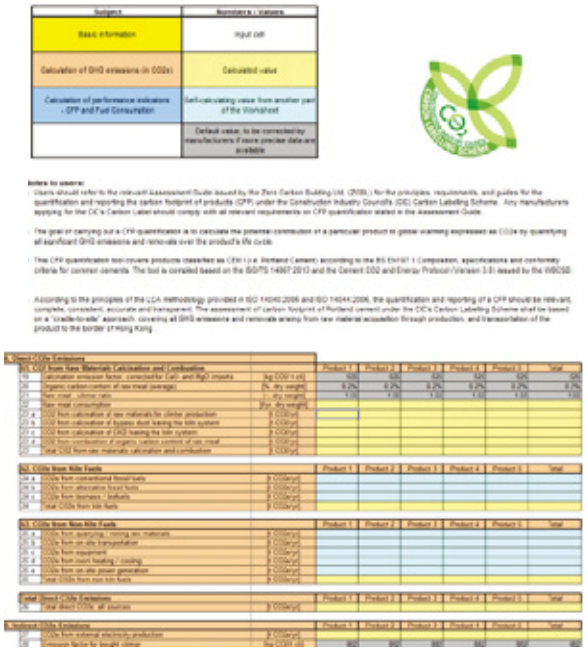

Figure 8 CFP assessment tool

As the first product-based carbon footprint assessment framework, its robustness, coverage, and user-friendliness must be carefully evaluated. The developed assessment frameworks were verified and enhanced by consulting 11 experts from related material suppliers. The validation was conducted in the form of face-to-face interviews with the product manufacturers of aluminium, cement, steel, glass and ceramic tiles. At the interviews, the process map, system boundary and computer tool were presented and discussed. Valuable feedback was collected which helped improve the assessment framework. Wider consultation was then conducted through a forum. At the forum construction professionals and carbon auditors expressed their views on how to further increase the accuracy of assessment especially when there is an absence of some first-hand information along the supply chain or production process. Based on their suggestions, relevant norms and supplementary information as identified from international guidelines and literature were incorporated into the computer model to cater for missing data.

Challenges

Based on the established carbon assessment frameworks, the carbon footprint of the selected materials can be measured. However, driving the industry stakeholders together to adopt and participate in the labelling scheme would never be an easy task, especially for this new born scheme because this would affect the supply chain from upstream to downstream, in terms of the impact on procurement plans. Concerns related to cost burdens, technology restriction, competitive distortions, and data availability have been raised. In this context, many challenges would need to be addressed in the implementation of the scheme in the Hong Kong construction industry.

The first difficulty is about "change", which means affecting the existing costs and practices. Faced with cost control and the deep-rooted conventional practices, the awareness of carbon reduction would become relatively weak in people's mind. As the engineering design and construction process for a particular type of structure is well established and highly efficient, even if an alternative material or design with a lower carbon footprint is identified, the developer may not be willing to switch as it could reduce the efficiency of the construction processes involved and thus increase the cost. In order to stimulate the industry practitioners' interest on the carbon labelling scheme, especially the bodies in the upstream of the supply chain, incentives should be provided to encourage government agencies, developers and client bodies to require more usage of low carbon materials. Only when the upstream clients raise the requirements, the designers, engineers and contractors would follow suit.

For the purpose of stimulating the local market supply and demand of low carbon materials, the scheme was developed for Hong Kong, however, it should not be limited to the Hong Kong market for its long term development. As Hong Kong imports a large amount and various types of construction materials from around the world, the labelling scheme should be applicable for products manufactured globally.

This requires the framework and benchmark to be in line with the international standards and worldwide average levels. On the other hand, a carbon assessment framework needs to be localised in order to represent the local carbon footprint level. The grading of the benchmark should be adjusted to local industry capacity and technological level to ensure it is practical and achievable. Therefore, data acquisition is a critical challenge when setting up benchmarks for a carbon dioxide labelling scheme.

Promotion of the scheme to the industry is another crucial task. It is hard to obtain recognition from the industry if the stakeholders especially the top leaders do not have the knowledge of carbon footprint and recognise its relevance to the construction industry. The gap between the awareness of low carbon construction and the real action to apply low carbon materials and practices results from the concern on cost and benefit. General promotional information regarding the climate change and global warming is normally shallow and superficial, focusing on the potential impact which does not touch on environmental investment and return. To further enhance industry practitioners' comprehension and encourage their participation into the scheme, a series of promotional events, such as seminars, workshops, and a well-designed training programme, have been organised to effectively deliver the key message as well as to emphasise the significance and benefit of the scheme.

Implementation of the CIC Carbon Labelling Scheme

Upon completion of the research conducted by HKU, the CIC took nearly one year to prepare the formal launch of the scheme in the industry. Three emission-intensive materials were covered in the initial launching stage, and they are: (i) Portland cement; (ii) reinforcing bar; and (iii) structural steel. The cement industry alone generates about 5% of the global anthropogenic CO2 emissions (IPCC, 2001). The iron and steel industry is responsible for 10% of fossil fuel consumption (IEA, 2008), which corresponds to about 5% of global GHG emissions.

In order to provide guidance to the users of the Excel tools and details the principles and requirements of the carbon assessment of each material, two Assessment Guides (Portland cement, Reinforcing Bar and Structural Steel) have been developed based on the frameworks and the newly release international standard on carbon footprint quantification and reporting at product level (ISO/TS 14067:2013).

Besides the content of the developed framework, the Assessment Guide introduces the certification procedures of applying the carbon label of the scheme, which go through the following three major steps: (i) carbon auditing; (ii) verification; and (iii) certification as shown in *Figure 9*.

Between the applicant and the label issuer, there are two other bodies involved: the Certified Carbon Auditor (CCA) and the Validation / Verification Body (VVB). The CCA is an individual who is qualified to conduct CFP quantification and reporting for a particular product category under this scheme. The CCA could be internal staff of the applicant organisation or externally engaged whereas the VVB should be an independent third-party organisation with the qualification of providing GHG validation and verification service. The engagement of CCA and VVB in the certification process is to make sure that the applied material's carbon footprint is correctly, accurately and completely audited, reported and verified in accordance with the Assessment Guide as well as the international standards.

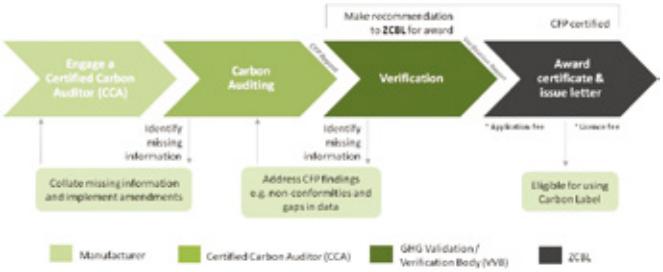

Figure 9 Certification process

Based on the results reported and verified, the carbon label (see *Figure 10*) could be issued accordingly. A corresponding grade (Grade A to Grade E) indicating the performance of the product will be labelled on the certificate. Due to the lack of local carbon footprint data, the current benchmarks are determined on an average level of recognised inventories worldwide, which represents the performance of products globally. In the long run, the benchmarks would be reviewed and adjusted on a regular basis, and will be replaced by local data if sufficient data are obtained as the scheme develops. In addition to the grade, the certificate presents the details of the product such as the name, company and country of origin; the carbon footprint distribution at different key life cycle stages; and the assessment method, and standards. The certified carbon label may appear for consumer information by print, online or other accessible media.

Figure 10 The CIC's carbon label

Riding on the recent impetus of low carbon construction, the CIC has been actively seeking support from client bodies by lobbying them to select labelled low carbon materials in the procurement for their own construction projects. The Development Bureau, Hong Kong Housing Authority, MTR Corporation and other developers have shown strong interest in the scheme and expressed their expectation on the certification of Hong Kong's first labelled construction material. The CIC has also organised several seminars, workshops and meetings to liaise with relevant stakeholders, such as the Hong Kong Accreditation Service (HKAS), potential carbon auditing services and certification bodies, contractors and material suppliers, to encourage their participation in the scheme. More importantly, the CIC is studying the appropriate approach of incorporating the scheme into the Beam Plus assessment system, with which stronger incentives could be provided to encourage developers to use more labelled materials.

Figure 11 Seminars and workshops on the Carbon Labelling Scheme

To provide basic knowledge about the carbon footprint of construction products and the scheme, as well as to offer professional training on CFP quantification, a series of training programmes under the scheme has been organised. The training programmes consist of Awareness Courses and Auditor Courses, which are delivered by experienced and well-known professors and experts in the low carbon research area.

The Awareness Course aims to provide essential information about the concept of the carbon footprint, the rationale behind the scheme, and its relevance to the construction industry and materials. The course also introduces possible carbon reduction strategies in terms of technology, policy and market measures. It attempts to change stakeholders' mind of seeing the environmental or sustainable initiative as a burden on the operations of construction companies, and to makes the participants believe that despite the start-up cost involved, joining the carbon labelling scheme will bring long term benefit on energy saving, waste reduction and competitiveness enhancement.

The Auditor Course is specific to each construction material. Currently, Auditor Course for cement and steel are being organised, respectively. The targeted audience are those professionals who would like to be registered as CCA with background knowledge and experience in carbon auditing, GHG validation and verification, and cement / steel manufacturing. Auditor Course aims to provide detailed guidance on how to use the Assessment Guides and quantification tool to calculate the CFP of a specific cement or steel product. Participants will have hands-on practice on CFP quantification and reporting.
Four Awareness Courses and two Auditor Courses have been successfully organised within the recent half a year since the launch of the Scheme. The courses are well-received in the industry and over 200 of participants attended the courses. In the future, more courses will be routinely arranged based on the feedbacks and needs of the market.

The way forward

The CIC and its Committee on Environment, Innovation and Technology will continue to support the implementation and development of the Carbon Labelling Scheme. The Phase II research will commence shortly which aims at covering an additional 10 construction product groups under the scheme. In order to further enhance the international visibility of the scheme and attract the attention of material manufacturers in Mainland China, Taiwan, Japan and other Asian countries and regions, the CIC will explore various channels to introduce and promote the scheme.

In the long run, the CIC will seek support from other relevant organisations, associations and institutes for information sharing to expand the coverage of the promotion. It is expected that the scheme will be widely recognised by the industry by achieving the incorporation of the scheme into the Beam Plus system, as well as providing incentives in the Government's procurement plan. As a Hong Kong-based voluntary scheme, it is intended to encourage the demand for, and supply of, low carbon products, thereby contributing to Hong Kong's transition to a low carbon economy.

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建造業議會建築產品碳標籤計劃

建築材料的含碳量是一個很重要卻又常被忽略的課題。由於在生產階段裡，對碳排放的評估缺乏統一標準的框架，因此難以準確預測含碳量。有鑑於此，建造業議會聯同香港大學進行建築產品碳標籤計劃的研究，並為全球第一個以產品為本的碳標籤計劃訂下了框架。

建造業消耗大量能源和資源，產生大量溫室氣體 (GHG)。根據世界自然基金會香港分會 (WWF-Hong Kong) 發表的《香港生態足印報告 2010》，建造業在 2007 年是香港碳足跡的第二大貢獻者。香港特區政府 (HKSAR) 根據 2005 年的數據，訂下減碳目標，計劃到 2020 年將碳強度減少 50%-60%。要達到這個目標，建造業實在責無旁貸。

在建築物的生命週期中，溫室氣體排放跟整個生命週期的各個階段息息相關：原材料採集、建築材料生產、材料運輸、現場施工、操作和維修，以及拆卸。研究人員和業內人士通常比較關注建築物在使用階段，或內部維修過程中使用熱能、冷卻、照明和操作電器時排放的氣體，原因是這些設施會長年累月使用，消耗大量能源。然而，建築物的含碳量同樣不能忽視，因為當建築物完工後，就難以降低含碳量 (Monahan and Powell, 2011)。 Fieldson 及其他人士 (2009) 同樣強調，在建築物生命週期排放量之中，建築材料的含碳量佔有舉足輕重的地位 (圖 1)。因此，在規劃初期選擇使用低碳建材是最理想的做法。

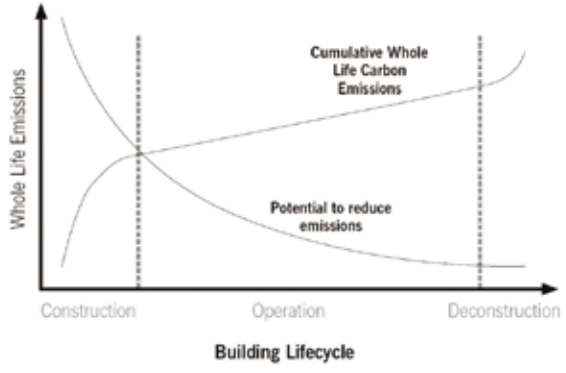

圖 1　在建築物生命週期中的減排潛力 (FIELDSON et al., 2009)

香港近年的總施工量和十大基建計劃，將會令建築服務和材料需求不斷上升，因此，市場對低碳建材的需求亦愈來愈大。然而，香港缺乏一個權威、獨立和公認的評估系統，為本地使用的建築材料訂立標準，促使業界持份者要求制訂公認的評估框架，標明每種常用的建築材料效能。

有見及此，建造業議會 (CIC) 展開與香港大學合作的研究計劃，制訂以溫室氣體排放量為基礎的建築材料碳標籤框架。經過十八個月的研究和調查，研究計劃在 2012 年底完成，為六項特定的建築材料類別 (水泥、結構鋼、鋼筋、鋁合金、玻璃和瓷磚) 制訂以香港為本的量化碳足跡框架。這個框架確定溫室氣體源頭的範圍，為材料碳足跡 (CFP) 的量化和報告載列原則、要求和指引，提出每項材料的碳足跡分級機制，以及就標籤計劃的實施策略和規劃作出建議。

根據這個框架，建造業議會在 2013 年底正式推出建築材料碳標籤計劃，為客戶、設計師、承建商和用家提供碳足跡的核查渠道和準確資料，以便他們選用低碳建材。最初，計劃涵蓋三種具有顯著溫室氣體排放量的常用建築材料，分別是水泥、結構鋼和鋼筋。建造業議會碳標籤計劃在 2014 年 2 月開始接受申請。

由展開研究到正式推出計劃的兩年多期間，有份參與的相關機構，包括建造業議會、香港大學、政府、業界及教育界人士均付出了巨大努力，以及提出建議和回應。本文將回顧已進行的工作、總結目前的進展，以及展望計劃的前景。本文亦會探討如何把框架付諸實行，以及在計劃的發展及實施階段遇到的挑戰，突顯建造業議會對促進創新研究推動行業發展的承諾。

為何需要碳標籤計劃

政府間氣候變化專門委員會 (IPCC) 在 2013 年發表的第五份評估報告 (AR5)，提出了令人憂慮的消息 --- 大氣中的溫室氣體已達到了前所未有的水平。 第五份評估報告提到，「1983 年至 2012 年期間，是北半球一千四百年來最溫暖的三十年。北極海冰和南極的冰蓋正在萎縮。而 1901 年以來，全球海水平均上升了 0.19 米。」(IPCC, 2013)

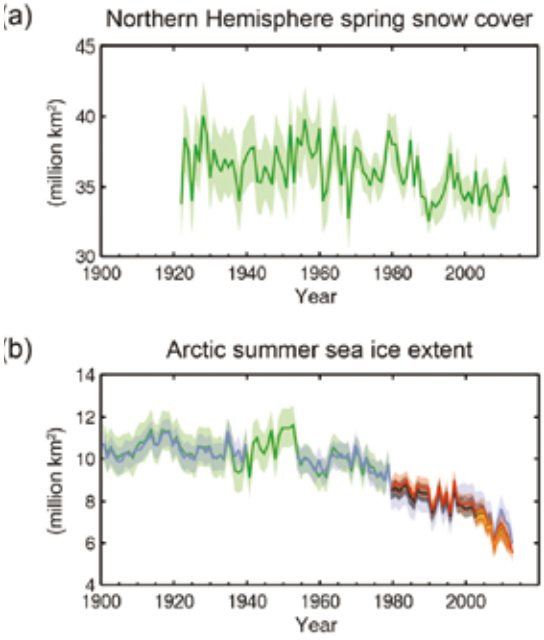

圖 2 1901 – 2010 年期間北極海冰面積 (左) 及全球海洋水平 (右) (IPCC, 2013)

香港天文台的紀錄顯示，在過去一百三十年來，香港的溫度以每十年攝氏 0.12 度的速度上升，而在最近的三十年，氣溫的上升速度更增加至每十年攝氏 0.20 度 (*圖 3*)。居住在全球人口密度最高城市的香港市民，對愈來愈嚴重的人為溫室氣體排放帶來的後果，深表關注。

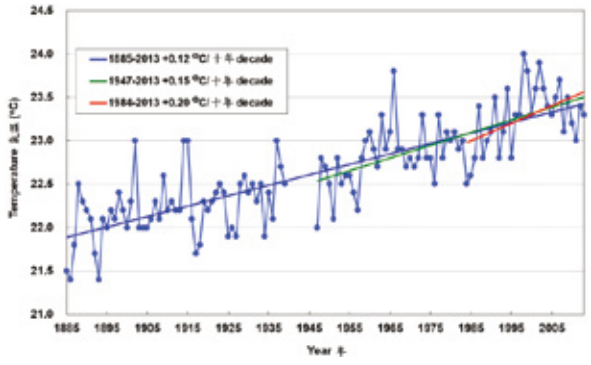

圖 3 香港天文台在 1885-2013 年期間紀錄的年平均氣溫 (HKO, 2014)

香港的建築物佔全港電力消耗量約九成，在改善能源效益以及減少建築和樓宇設施的碳排放量方面，具有極大潛力。本地建造業的當務之急就是為邁向低碳建築採取行動。近年，我們很高興看見綠色建築評估計劃 (BEAM-Plus) 受到發展商歡迎，提高了樓宇的能源效益和環保效能。建築物能源效益條例 (第 610 章) 在 2012 年 9 月生效，要求新落成樓宇和現有樓宇進行重大改建時，四項主要樓宇設施裝置 (空調、電力、升降機及電梯，以及照明系統)，均需要符合建築物能源效益守則列明的能源效益標準和要求 (香港政府一站通 , 2014)。

以上提及的措施主要聚焦於樓宇在使用階段的能源效益和排放量。建築材料的碳足跡其實同樣重要，但往往被忽視。以往的研究顯示，單是生產建築材料過程的溫室氣體排放量，已佔建築階段的 70% (Smith et al., 2002)，而在樓宇壽命消耗能源方面，亦佔 15% (Harris, 1999)。如果在設計及建築階段已選用低碳建材，就可以大幅減低建築生命週期的含碳量。因此謹慎選用低碳建築材料，是最大限度地減少溫室氣體排放的可取方法。

鑑於市場上對於低碳建材的資訊貧乏和參差，加上本地市場需要一套選用低碳建材的統一標籤制度，建造業議會轄下的環境及技術委員會 (Com-ENT) 委託香港大學的研究小組，進行碳標籤框架的研究，讓製造商計算產品的碳足跡，以及更重要的是，識別潛在的減排機會。環境及技術委員會轄下的碳標籤框架專責小組由黃天祥工程師領導，負責監督及監測研究的進展。專責小組成員包括教授、工程師、專家和業界領袖，在整個研究期間和實施階段，提供了專業和有建設性的意見。

框架發展

為了建立碳標籤框架，研究計劃在四個不同但又互相關聯的階段，使用特別設計的研究方法進行，如*圖 4* 所列。

圖 4 研究方法

研究的初期階段進行了一系列的半結構性訪談，向來自政府、發展商、非政府組織、顧問、承建商及物料供應商等業內人士，收集對建立新碳標籤計劃的意見。大部份受訪的專業人士對業界減少碳足跡的議題非常感興趣，並認為要在香港建造業推廣使用低碳建材，訂立建材碳標籤計劃是勢在必行。受訪的業內人士亦同意，應為建築材料訂立生命週期溫室排放標籤，標明它們對全球氣候變化的影響。此外，亦應根據本土情況和國際標

準訂立一個基準機制。為了有效實施標籤計劃，上游供應鏈如政府機構、客戶和發展商的承諾和支持都是必要的。

接著，研究進展到材料的分類和選擇。研究建議為標籤計劃訂下三層物料分類制度。標籤計劃的分類系統首先是根據聯合國統計委員會頒布的中央產品分類，然後是英國巴斯大學編制的碳和能源（ICE）庫存材料分類。產品層面的分類應按照包含詳細產品分類的相關國際標準來制訂，然後按材料的具體特點進行嚴格的檢查和分類。這樣，就可以為在規定的產品類別內的建材進行碳足跡基準測試，持續改善碳減排情況。

在為框架選擇材料時，是根據 80/20 法則，選用有顯著排放量的材料。此外，工料清單（BQ）調查會評估現實生活的建築項目材料使用量及有關的碳足跡。工料清單的調查結果顯示，以碳足跡來說，香港常用的六種建築材料分別是水泥、結構鋼、鋼筋、鋁合金、玻璃和瓷磚。其他在前列位置的材料包括混凝土、木材、鑄鐵、磚塊和石塊，未來都會納入碳標籤計劃。

六種特定建材的標籤框架已經訂立，當中包括 (i) 產品分類和相關項目的定義；(ii) 用於識別特定產品的溫室氣體排放源頭的系統邊界和流程；(iii) 以 MicrosoftTM Excel 格式顯示的碳足跡評估工具，讓物料供應商計算及匯報溫室氣體排放的源頭及引致排放的因素，例如交通運輸和燃料；以及 (iv) 基準機制。

碳標籤框架

碳標籤計劃包含京都議定書 (聯合國，1997) 所訂定的六種直接影響全球暖化的溫室氣體，分別是二氧化碳 (CO2)、甲烷 (CH4)、一氧化二氮 (N2O)、氫氟碳化物 (HFCs)、全氟化碳 (PFCs) 和六氟化硫 (SF6)。其中二氧化碳 CO2 等同量化的 (CO2e)。計劃的系統邊界設定為「從搖籃到工地」，涵蓋原材料採集、材料製造，直至建材運送到香港邊境 (*圖 5*)。

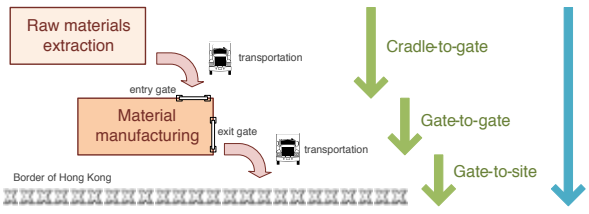

圖 5　從搖籃到工地系統邊界

"產品的碳足跡是量度由原料採集到製造過程，直至建材運到香港邊境期間的碳排放量。建築材料的壽命只有幾十年，使得它不可能準確地評估從使用階段和隨後的處置階段所產生的碳足跡。"

採用碳足跡評估工具量化碳排放時，必需遵守一些基本原則，確保每項評估工作公平和可靠。根據 ISO 14040:2006 及 ISO 14044:2006 的生命週期評估方法 (LCA)，這些基本原則包括 (*圖 4*):

- 關聯：根據研究的產品體系產生的溫室氣體排放和輸出，適當地選擇數據和評估方法。
- 完整性：根據研究的產品體系，包括所有會導致大量碳足跡的溫室氣體排放和輸出。
- 一致性：在整個碳足跡研究過程中，採用同樣的方式引用假設、方法和數據，以達致符合目標和範圍定義的結論。
- 準確性：確保碳足跡的量化和傳輸準確、可核查、有關聯，以及不會引起誤導，而且在可行情況下減少偏見及不確定性。
- 透明度：以開放、全面和可以理解的資訊發表和存儲所有有關的訊息。透露有關的假設，適當引用方法和數據來源。清楚地解釋估算，避免出現偏見，令碳足跡研究報告能真實地反映情況。

圖 6　碳足跡量化和報告的原則

為了發展碳足跡評估工具，首次編制了描繪六個特定建築材料生命週期生產過程的流程圖，並根據 ISO/TS 14067:2013、ISO 14044:2006、 IPCC 2006　和 PAS 2050:2011 等標準，確定相關的溫室氣體排放源。*圖 7* 展示了水泥產品的流程圖，列明每一個生命週期涉及的排放源，例如燃料耗用量、化學作用和揮發性氣體等。隨後，材料供應商可透過 Microsoft™ Excel 格式的碳足跡評估工具，為特定產品準備碳庫存。

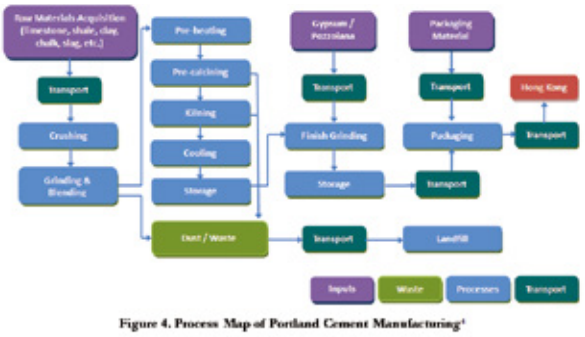

Figure 4. Process Map of Portland Cement Manufacturing[4]

圖 7　製造波特蘭水泥的流程圖

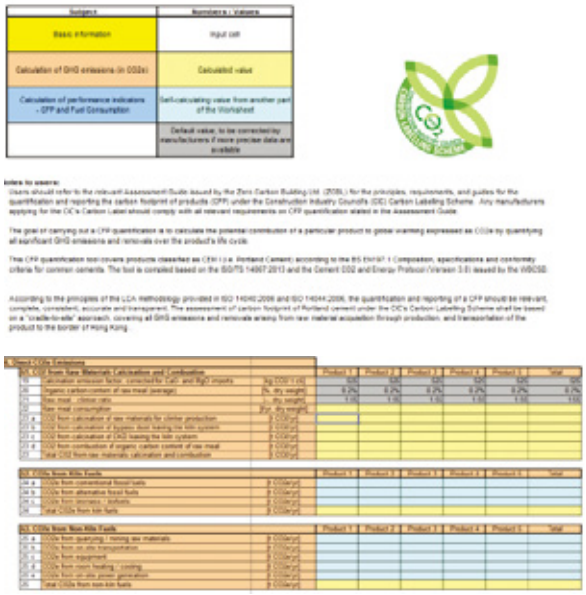

圖 8　碳足跡評估工具

作為首個以產品為本的碳足跡評估框架，其堅固性、覆蓋範圍和方便使用的程度，都必須仔細評估。評估框架諮詢過有關材料供應商的 11 名專家，進行驗證和改良。驗證方式是透過跟鋁金合、水泥、鋼鐵、玻璃和瓷磚等產品的製造商，以面對面訪談形式進行。在訪談中討論了流程圖、系統邊界和電腦工具等，並收集了很多有助改良評估框架的寶貴意見。隨後又透過論壇進行了更廣泛的諮詢。在論壇上，建築界專業人士和碳審計員表達了如何加強評估準確性的意見，特別是當供應鏈或生產過程中缺乏第一手資料時。根據這些建議，國際準則和文獻中的有關規範和補充信息，均被納入電腦模型中，以彌補缺少的數據。

挑戰

根據已訂立的碳評估框架，特定材料中的碳足跡是可以量度的。然而，要促使業界持份者共同接受和參與標籤計劃，並非易事，尤其是這個新計劃會影響由上至下的供應鏈，從而影響整個採購計劃。亦有人提出有關成本負擔、技術限制、降低競爭力和數據可用性等憂慮。在此背景下，香港建築業要實施計劃，就先要解決許多問題。

第一個要面對的問題是「改變」，即是改變現行的成本和做法。與控制成本和根深蒂固的常規做法比較，「減碳」這個概念在人們心目中就相對薄弱。由於特定類型結構的工程設計和施工過程已發展成熟而且公認是高效率，就算有一些含低碳足跡的材料和設計出現，發展商也未必願意作出更改，因為這可能會降低建築過程的效率，令成本上升。為了加強業內人士，特別是上游供應鏈對碳標籤計劃的興趣，必須鼓勵政府機構、發展商和客戶採用更多低碳材料。只要上游客戶提出要求，設計師、工程師和承包商就會跟隨。

為了刺激本土市場對低碳材料的需求，此計劃是專為香港而設計的；然而，為了長遠發展，不應只局限於香港市場。由於香港從外國進口大量不同種類的建築材料，此標籤計劃應適用於在全球各地製造的建材。這樣，框架和基準必須符合國際標準和平均水平。另一方面，碳評估框架也必須本地化，與本土碳足跡水平同步。基準的分級必須調節到與本土行業能力和技術水平相符，才可以應用和實踐。因此，為碳標籤計劃訂立基準時，數據採集是個嚴峻的挑戰。

向業界推廣這個計劃亦是另一項嚴峻挑戰。如果業界的領袖缺乏對碳足跡的認識，或不了解其與建築業的關係，就很難得到業界持份者的認同。對成本和效益的關注，令了解低碳建築和真正採用低碳建材和做法，出現了很大的差距。一般有關氣候變化和全球暖化的宣傳訊息，大多數是流於粗淺和表面，只著眼於潛在的影響，沒有觸及環保投資與回報。為了進一步提高業內人士對計劃的了解和鼓勵他們參與，當局展開了一系列宣傳活動，包括舉辦講座、工作坊和培訓課程等，向業界宣揚重要的訊息，展示計劃的重要性和好處。

建造業議會碳標籤計劃的實施

香港大學進行的研究完成後，建造業議會用了將近一年時間為推出計劃做準備。在計劃推行初期，涵蓋了三種較高碳排放量的建材，分別是波特蘭水泥、鋼筋以及結構鋼。單是水泥行業，就已佔了全球人為二氧化碳排放量的 5% (IPCC, 2001)；鋼鐵行業佔化石燃料消耗的 10% (IEA, 2008)，相當於與全球溫室氣體排放量的大約 5%。

為了向 Excel 工具的用家提供指引，以及詳細列明每種材料的碳評估準則和要求，此計劃根據框架及新發表的產品層面量化和和報告溫室氣體的原則和要求 (ISO/TS 14067:2013)，訂立了兩項「評估指引」(波特蘭水泥、鋼筋及結構鋼)。

除了框架內容之外，評估指引亦列明了申請碳標籤所需的驗證程序。程序主要分為三個步驟：(i) 碳審計；(ii) 核查；及 (iii) 圖 9 顯示的驗證程序。除了申請者及簽發標籤機構之外，中間亦涉及兩個機構：認可碳審計員 (CCA) 和審定及核查機構 (VVB)。認可碳審計員 (CCA) 是在計劃之下，替特定材料進行認可碳足跡量化和報告的人士。認可碳審計員 (CCA) 可以是申請機構的內部員工，或外部參與者，而審定及核查機構 (VVB) 必須為認可提供溫室氣體審定和核查服務的獨立第三者機構。認可碳審計員 (CCA) 和審定及核查機構 (VVB) 的參與，是為了確保碳足跡得到準確和全面的審定、報告和核查，符合評估指引和國際標準。

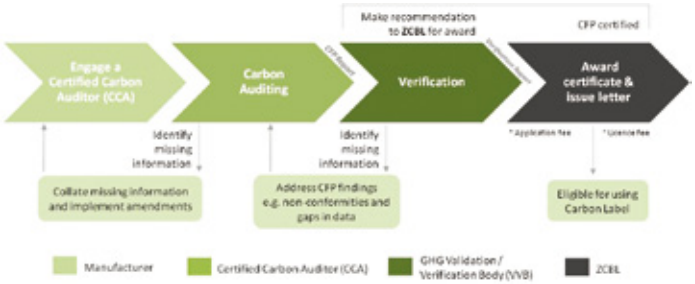

圖 9　認證流程

根據報告和核查的結果，就可以簽發碳標籤 (*圖 10*)。表明產品性能的相應等級（A 至 E 級）認證將會貼在產品上。由於缺乏本地碳排放數據，目前的基準測試是根據代表全球產品性能的環球庫存認可平均水平而定。長遠而言，基準測試會定期進行檢討和調節；而隨著計劃不斷發展，收集到更多數據之後，就會以本土數據取代。除了等級之外，認證上亦會列出產品的詳細資料，例如名稱、公司及來源地、在生命週期每個不同階段的碳足跡分佈、以及評估方式和標準。碳標籤認證亦可以透過印刷、網上或其他媒體等方式展示予消費者。

圖 10 建造業議會的碳標籤

隨著近年推動低碳建設的努力，建造業議會一直積極尋求客戶的支持，游說他們在採購時選用獲標籤認證的低碳建材。發展局、香港房屋委員會、港鐵及其他發展商都對計劃表示高度興趣，並對香港首個碳標籤建材認證寄以厚望。建造業議會亦舉辦了多場講座、工作坊和研討會，聯繫相關的持份者，例如香港認可處 (HKAS)、潛在的碳審計服務和認證機構、承建商和材料供應商等，鼓勵他們參與計劃。更重要的是，建造業議會正與香港綠色建築議會合作，尋求將碳標籤計劃與綠色建築評估計劃連接，提供更大動力鼓勵發展商採用更多獲標籤認證的建材。

為了提供更多有關建築材料碳足跡和標籤計劃的基本知識，以及提供碳足跡量化的專業培訓，當局開辦了一系列培訓課程，包括認知課程及審計課程，由低碳研究領域內有豐富經驗及知名的教授和專家主講。

認知課程旨在提供有關碳足跡概念的基本資訊、背後的理念、以及它與建築行業和材料的關係。該課程也會介紹減碳策略的技術、政策和市場措施，嘗試改變持份者認為環保和可持續議題會為建築公司帶來運營負擔的看法，並讓參加者明白，儘管涉及開辦成本，加入碳標籤計劃可以在節能、減廢及加強競爭力等方面，帶來長遠利益。

圖 11 碳標籤計劃講座及工作坊

至於審計課程是專為每種建材而設，目前已開設了有關水泥和鋼的審計課程。課程的目標參與者是計劃成為認可碳審計員的專業人士，須具備碳審計、溫室氣體審定與核查，以及生產水泥 / 鋼等基本知識與經驗。審計課程旨在為如何使用評估指引和量化工具測量水泥或鋼產品碳足跡，提供詳盡的指引。參加者將會親身進行碳足跡量化和報告訓練。

標籤計劃實施半以來，已舉辦了四個認知課程和兩個審計課程，受到業內人士歡迎，超過二百人參與。因應市場的反應和需求，未來將會定期開辦更多課程。

前瞻

建造業議會及其屬下的環境、創新和技術專責委員會將繼續支持碳標籤計劃的實施和發展。第二階段研究即將展開，主要涵蓋多十種建築產品組別。為了向國際展示這個計劃，以及吸引更多中國大陸、台灣、日本和其他亞洲地區材料製造商的關注，建造業議會將尋找更多渠道推廣計劃。

長遠而言，建造業議會將尋求與其他相關機構、協會和組織分享資訊，以擴大推廣的規模。期望碳標籤計劃與綠色建築評估計劃連接後，可以得到業界更廣泛認同，以及提供鼓勵予政府的採購計劃。作為以香港為本的自願性計劃，碳標籤計劃旨在推動低碳產品的需求和供應，從而促進香港邁向低碳經濟。

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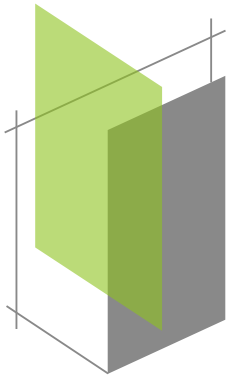
李俊暉工程師

李俊暉工程師是建造業議會（議會）研究經理，加入議會前曾任 Worley Parsons Pte Ltd 首席工程師（土木及結構）和 Arup Singapore Pte Ltd 高級工程師。李先生是英國特許土木工程師及香港註冊專業工程師，在建造業擁有超過 15 年經驗，曾管理許多不同類型的建設項目包括發電廠、鐵路、地下隧道和建築發展等。李工程師致力推動創新科技和良好作業方式，於議會內負責管理與建築有關的研究項目如建材碳標籤等，以減少行業對環境的影響。

黃明華博士

黃明華博士是建造業議會研究主任，負責推動研究項目的應用和實踐，以及推行與香港建造業相關的研究成果。黃博士持有香港理工大學建築技術和管理學士學位及建築經濟博士學位，後於香港大學土木工程系擔任博士後研究員，管理多元化的建築相關研究和諮詢項目，包括建築經濟與預測、工程採購、項目管理、專業發展及可持續發展建築。



Construction 2025

Don WARD, Chief Executive of Constructing Excellence, reports on the latest UK strategy for improving the construction sector, and in particular how informed construction clients in the UK are procuring for value using new models of procurement based on early contractor involvement.

In July last year the UK Government in partnership with the industry published *Construction 2025*, the latest version of the UK strategy to improve the performance of its construction sector. UK initiatives date back to the 1990s LATHAM and EGAN reports and the 2008 Constructing Excellence report, *Never Waste a Good Crisis*. This is one of a number of industrial strategies for sectors seen as crucial for economic growth, and it is worthy of note that construction is acknowledged as one of these sectors, alongside automotive, aerospace, creative industries, professional services and retail.

It sets out a vision and a plan for long-term strategic action by government and industry to continue to work together to promote the success of the UK construction sector, and focuses on key growth markets in smart technologies, green construction and overseas trade.

Informed clients

The built environment sector is increasingly being driven to do more for less, and to think globally and long-term, not just locally and short-term, about the solutions it offers. In the UK we face major challenges in delivery, for example in housebuilding, schools, low carbon refurbishment, water and rail programmes. Informed forward-thinking client organisations and their supply-side partners, are responding to economic, regulation, technology, sustainability and global factors. They are increasingly thinking internationally and long-term, about programmes not projects; demanding detailed data about assets and their performance; trialling new procurement regimes; building alliances with their delivery organisations; and incentivising teams to deliver more efficiently, more predictably, with better outcomes.

The requirements of informed clients centre around:

Efficiency : the ability to strip out all non-value-adding activities and process

Performance : the ability to measure value and to use data to drive performance improvement

Outcomes : the ability to define value and to organise around, and deliver outcomes

Predictability : the ability to control and mitigate risk.

A 'burning platform'

Our view is that the industry as currently organised will not be able to achieve exceptional performance as experienced by other industries. Current client-supplier relationships and supply chain business models create a barrier to achieving performance beyond best practice or the opportunity to secure continual improvements on their programmes and projects. The economy has created a 'burning platform', a fundamental challenge to the way we do business and the future prosperity of our industry, and leading players need to respond radically. We need to move beyond incremental efficiency improvement and so-called best practice to achieve genuinely exceptional performance so that it figures among the world's leaders. These leaders will have increasingly global, long-term business models, be data and knowledge-rich, be able to fund, deliver, operate and manage at higher levels of risk,

be coordinated – not fragmented – and collaborative in their approach to innovation, and as a result, be rewarded for the value they create.

Reward by value will become the basis for getting paid. The business relationship between client and contractor will be revolutionised. Businesses will only survive if they can deliver client outcomes and create improved performances that allow the UK industry to thrive at home and to compete at a global level.

Vision of excellence

Construction 2025 is important in refocusing the UK sector as the economy emerges from recession. Confidence is up, and forward-looking companies seek a longer-term vision to work towards, rather than simply repeat the short-term opportunism and exploitation which caused such difficulties in the recession and in previous eras. By 2025 the industry needs to be remodelled to create the clear, predictable and sustainable long-term value that will be increasingly demanded by investors, customers and end users.

By 2025 we see that:

- The industry will be viewed as attractive for investment and careers, both domestically and internationally. It will have addressed how it is educated, structured, funded, led and motivated to collaborate and continually innovate.
- Business relationships between client and supply-side will have changed radically; businesses' long-term success will depend on delivering (even exceeding) client's desired outcomes.
- Exceptional performance will mean engaging in 'lean' ways that make best use of the people, technologies, data (from BIM to real-time asset information), and other resources.
- All industry organisations will be measuring, reporting and sharing data about their performance so that progress towards exacting SMART targets can be monitored.
- New models of procurement will help deliver appropriate margins and encourage innovation; through gain- and pain-sharing mechanisms for the best possible whole-life outcome.
- With integrated "TotEx" solutions, current client-side and supply-side 'silos' will erode and disappear to be replaced by more 'alliance networks' focused on holistic, optimal outcomes.
- Incentivised by their financial stake in the project or programme, the supply side will take 'ownership' as they become a shareholder in the wider venture, working as partners to conceptualise, fund, design, deliver, operate, maintain and eventually reuse our built assets.
- The attitudes and behaviours of end-users of our built assets will also become a factor in assessing their whole life value, encouraging a virtuous spiral of continuous improvement that helps embed user experience as a critical success factor for our built projects.
- Reward for value will be the new way of getting paid.

Modern procurement approaches

Three important strands of the *Construction 2025* strategy are sustainability, BIM, and client procurement. With regards to the latter it builds on the 2011 *Government Construction [Client] Strategy* which set out to achieve savings of up to 20% in public sector construction expenditure by making efficiencies through reforming procurement practices and effecting behavioural and cultural change. To date the Government has reported savings under this strategy of £447 million in 2012/13 and £293 million to the half year in 2013/14. For the last 18 months the Government has worked with Constructing Excellence and others to establish a programme to trial three new models of procurement: Cost Led Procurement; Integrated Project Insurance; and Two Stage Open Book.

These models are founded on delivery by integrated project teams working collaboratively. Along with reducing costs, the models are expected to contribute to improved programme certainty, reduce risk, encourage greater innovation, and improve relationships across clients and the supply chain. They change the way public sector clients procure to a process where the supply chain responds to an outline client requirement and declared budget. This contrasts with the historical process of the supply chain building up a price against a detailed client requirement without understanding what the client can afford. As such the models do not aim to deliver the cheapest tender price, necessarily, but rather will deliver the most cost effective and value for money outcome.

The models all require clients to:

- Clearly define the desired functional outcome including specific requirements, e.g., carbon reduction, use of apprentices etc.
- Identify typical costs and delivering the outcomes based on available data, benchmarking and cost-planning work. This will enable the client to set a realistic yet challenging cost ceiling, that would be achieved or bettered, and costs would be further reduced over a series of projects or programmes of work.
- Engage with the supply chain that embraces the principles of Early Contractor Involvement and a high

level of supply chain integration; and ensure that on completion of the capital phase the specified output performance is achieved.
- Apply a robust review process to ensure appropriate scheme definition, create commercial tension, monitor scheme development and address any unnecessary scope, risks and potentially missed opportunities.
- Take steps to ensure that those appointed to carry out the processes of the models, whether internal or external to the client organisation, have the skills to do so effectively.

The specific features of each of the three models of procurement are as follows:

- Cost Led Procurement

  The client selects one or more integrated supply chain teams from a framework. Teams are selected on their ability to work in a collaborative fashion to deliver below the cost ceiling on the first project, and achieve cost reductions on subsequent projects while maintaining the required quality outcomes.

  In competition, two or three integrated framework supply teams are then given the opportunity early in the life of projects to develop their bids with the client team, allowing them to bring their experience to innovate and drive cost reductions. Provided at least one of the supply teams can beat the cost ceiling, it will be selected on the relative scored attractiveness of its commercial and physical proposition and of its team members before being awarded the contract to deliver the project.

  Should none of the teams be able to deliver the work within the affordable budget, the project is offered to suppliers outside the framework. The expectation is that this would be unusual on a well-managed framework delivering similar types of projects, where the client and suppliers have an excellent understanding of cost.

  If the scheme price cannot be matched or bettered, it should not proceed. Under these circumstances the client may have to reconsider its budget or specification. There is a burden on the client to select a realistically challenging price, and work to enable its achievement by the industry supply chain.

- Integrated Project Insurance

  The client holds a competition to appoint the members of an integrated project team which will be responsible for delivering of the project. Scoring may include elements assessing competence, capability, proven track record, maturity of behaviours, proposals for removing waste and inefficiency, and fee declaration.

  The chosen team then works up a preferred solution that will deliver the outcome defined by the client, with savings against existing cost benchmarks.

  The difference between this and existing procurement models is the adoption of a single, third-party assured insurance policy to cover risks associated with delivery of the project. This policy packages up all construction-related insurances currently held by the client and supply chain members. It also takes a top slice of commercial risks, covering any cost overruns on the project above and beyond a "pain-share" threshold which is split transparently between client and the contracted parties (including key members of the supply chain).

  The model introduces third party independent facilitation and assurance of the scheme through a series of gateways. The facilitation helps ensure good value for money and that a wholesome, balanced commercial position has been struck which an insurer can take on board.

  With excess cost overruns covered by this policy up to a "cap", it removes the potential for a blame culture to try to pass on liability within the team. Payment of claims is based on the demonstration of loss not the assignment of blame. Yet in order to secure the insurance in the first place, the team will have to prepare a credible proposal, validated by the independent expert assurer to ensure that the commercial tension is maintained, and that the insurer is comfortable that it can be delivered.

- Two Stage Open Book

  This model sees the client invite prospective team members for a single project or from a framework to bid for a project based on an outline brief and cost benchmark. A number of contractors and consultant teams compete for the contract in a first stage with bidders being chosen based on their capacity, capability, stability, experience, strength of their supply chain, and fee (profit plus company overhead). As a second stage, the successful contractor and consultant team are appointed to work up a proposal on the basis of an open book cost that meets the client's stated outcomes and cost benchmark.

The approach reduces industry bidding costs, enabling faster mobilisation and in providing the opportunity for clients to work earlier with a single integrated team testing design, cost and risk issues ahead of start on site on award at the end of the second stage.

At the heart of this model is a systematic approach to early contractor/subcontractor engagement. The model includes deadlines for their design and risk contributions during the first stage, and has an agreed fixed price and clear risk profile before the client authorises the construction stage.

Trial projects

Our current Trial Projects programme for the Government is monitoring some 20 public sector projects which seek to demonstrate the above procurement approaches. Published case study reports help ensure that central and local government learn from the trial projects, so that the effective processes can be adopted across public sector construction projects. The early reports highlight savings and review the full extent to which the common characteristics, specific features and other key initiatives such as building information modelling (BIM) and Government Soft Landings have been implemented. They also highlight important enablers for efficiency relating to the strategic procurement context, e.g. the use of frameworks to deliver strategic relationships and continuous improvement. More information is available here: www.gov.uk/government/collections/new-models-of-construction-procurement

Conclusion

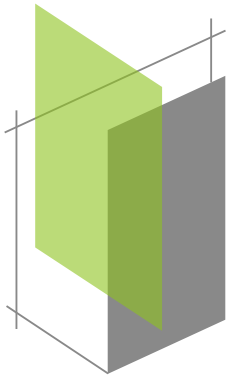
Construction 2025 updates the vision for the UK construction sector, which continues to build on the legacy of previous government-industry initiatives led by LATHAM and EGAN in the 1990s. The language and tools continue to evolve, with BIM seen as a key enabler for the efficiency gains long since envisaged, but the foundation stones remain clear: integration and collaborative working.

Increasingly it is inappropriate to talk of the 'construction industry' as though it is separate to the needs of investors, customers or end-users. Our buildings, infrastructure and landscape not only need to be planned, designed and created, they also need to be appropriately financed and then managed to deliver value throughout their useful lives before being efficiently decommissioned or redeployed. Industry business models need to change from vertical contracting, with profit derived mainly through revenue, to an integrated model where organisations are rewarded on the value they create. Industry needs to stimulate innovation and overcome the structural, transactional, contractual and competitive barriers which currently fragment its efforts. A new set of capabilities is required. Funding and finance, BIM, asset management and collaborative working throughout the supply chain will be the foundation for success, and the values of excellence, personal and corporate integrity, trust and respect for people will be vital. Surely this vision needs to be realised before 2025.

About the author

Mr. Don WARD

Mr. Don WARD is a leading figure in the UK construction industry reform movement, and is a passionate champion of collaborative working in all its forms. He specialises in industry change, supply chain integration, collaborative working, benchmarking and sustainability, with almost 30 years' experience of studying, implementing and learning from best practice and change programmes in the construction and infrastructure industries in the UK and overseas. He is an advisor to the UK Government's Cabinet Office, and is also Executive Director of the Centre for Infrastructure Development at Manchester Business School.



Construction 2025

英國 Constructing Excellence 行政總裁 Don WARD 先生談及英國改善建造業的策略，集中討論英國的知情建築客戶如何運用以「承建商早期參與」為本的全新採購模式達致「購有所值」。

去年七月，英國政府與建造業界合作發表了改善業界表現的最新文件《Construction 2025》。上一次英國發表同類刊物可追溯至 90 年代的 LATHAM 和 EGAN 報告，以及其後 Constructing Excellence 於 2008 年發表的《Never Waste a Good Crisis》。值得一提的是，一系列的行業策略均針對有助經濟增長的重要行業，言則建造業與汽車、航天科技、創意產業、專業服務和零售業正並駕齊驅。

文件中提出了一個願景，為政府和行業定下了長期的策略性行動，共同推動英國建造業的成功，並專注於智能技術、綠色建築與海外貿易等主要發展市場。

知情客戶

今天，建築及環境工業要做到事半功倍，在策劃項目時必須作全球性和長遠的思考，不能再單單考慮本地和短期的因素。在英國，不論是興建住宅樓宇和學校還是進行低碳翻新、水利和鐵路等各類工程項目時，我們均面臨嚴峻的挑戰。深謀遠慮的知情客戶組織和他們的供應伙伴均積極參考經濟、法規、科技、可持續性和全球性等因素。他們的目光越趨長遠，放眼國際，著重於整體發展而非單一項目；他們要求掌握各項資產及其表現的詳細數據，並試用新的採購制度；他們更與承建組織建立聯盟，並鼓勵團隊更有效地建立更可預測和更好的成果。

知情客戶的要求主要圍繞：

效　　率：排除所有無增值能力的活動和程序
表　　現：衡量價值並運用數據來提高表現
成　　果：訂定價值，目標為本
可預測性：控制和緩減風險

「水深火熱」

我們認為現時的結構不利建造業達致其他行業的超卓表現。目前客戶和供應商的關係以及供應鏈的經營模式形成了一道屏障，窒礙業界超越最佳作業表現，亦使他們的項目失去持續進步的機會。經濟環境使行業陷入「水深火熱」之中，挑戰我們的經營方式和行業的未來發展，使主要持分者不得不激烈回應。我們不能滿足於提升效率和所謂的最佳作業，我們必須做到真正與眾不同的超卓表現，以吸引全球領袖的目光。這些領袖的經營模式將越趨長遠和全球化，他們掌握豐富的數據和知識，在高風險中仍能提供資金，執行、營運和管理，創新時不忘協調合作，最終獲得與他們創造的價值相等的酬賞。

按價值酬賞將成為新一代的經營基礎。客戶和承建商之間的業務關係將面臨巨大轉變。唯有能交付客戶期望成果及創造更好表現的業務，才能使建造業在國內蓬勃發展、在全球傲視同儕。

高瞻遠矚

在這段經濟復甦時期，《Construction 2025》正好為英國建造業重新定向。經濟衰退時和前期的短期機會主義和過度開發曾經造成種種困難，現時企業信心回升，必會把目光放在更長遠的目標上，絕不重蹈覆轍。行業亦必須變革，以期在 2025 年創造出投資者、客戶和用戶越趨追求的明確、可預測和可持續的長遠價值。

到 2025 年，我們預期：

- 不管在國內和國際上、投資還是就業，建造業是最有吸引力的行業。行業的教育、結構、資金、領導和動力也驅使業內通力合作和不斷創新。

- 客戶和供應方之間的業務關係將有重大變化，能夠交付（甚至超越）客戶期望成果的企業將取得長期成功。
- 卓越表現的定義是採用「精益」方式令人力、技術、數據（從 BIM 到實時資產訊息）和其他資源物盡其用。
- 所有行業組織將量度、報告並分享他們的表現數據，以監察進度，達至嚴格的 SMART 目標。
- 嶄新的採購模式能創造適當的利潤及鼓勵創新；並透過盈虧分擔機制以達致最佳終生成果。
- 全面採用「TotEx」技術，目前的客戶和供應雙方的「儲備」逐漸消失，取而代之的是側重於達致整體、最佳成果的「聯盟網絡」。
- 受到項目財務注資的鼓勵，供應方可成為更廣泛合資項目的「持有人」之一而取得擁有權，並以合夥身分構思、投資、設計、興建、營運、維護並最終重用我們的建築資產。
- 用戶的態度和行為也是評估建築資產終生價值的因素之一，鼓勵持續改進的良性循環，使用戶體驗成為建築項目的成功關鍵。
- 按價值酬賞將是最新的經營方式。

現代採購方法

《Construction 2025》的三個主要意念是可持續性、建築資訊模型（BIM）和客戶採購。2011 年《Government Construction Strategy》（客戶）提出改革採購方法和帶領行為和文化的改變以節省達 20 的工務工程開支，客戶採購正是這方面的延續。措施實施至今，政府報告 2012/13 的庫房儲備增加 4.47 億英鎊，2013/14 上半年增加 2.93 億英鎊。在過去 18 個月中，政府與 Constructing Excellence 及其他機構共同訂立了一套方案，試行三款全新的採購模式：成本主導採購、綜合項目保險、以及二段招標。

這些採購模式均是由綜合項目團隊協同合作交付成果。除了降低成本，這些模式預計將提高工程的確定性，並降低風險、鼓勵創新、鞏固客戶和供應雙方的整體關係。有別於工務工程一貫的採購模式，它們讓供應商按照客戶的要求大綱和財政預算作出回應。這與以往供應商針對客戶的具體要求訂出價格而忽略客戶負擔能力的採購方式可謂截然不同。因此，這些全新的採購模型不再旨在價低者得，而更著重於找出最符合成本效益和價值的供應商。

這些採購模式均要求客戶：

- 清楚定義並詳細羅列完成品在功能上的期望，例如減少碳排放，僱用學徒等。
- 參考已有的數據、基準和成本規劃，識別基本成本和交付成果。客戶可訂立一個實際可行同時具有挑戰性的成本上限作為目標，並在其後一系列的工作項目中逐步降低成本。
- 採用願意早期參與的承建商和高度整合的供應鏈，並確保在完成資本階段能達到指定的生產表現。
- 採用強大的審查程序以確保適當的工程計劃定義、創造商業緊張狀態、監察計劃發展，並摒除任何不必要的規範、風險和可能錯失的機會。
- 採取措施以確保那些獲委任者，不論是否從屬於客戶組織，均有能力有效地執行這個採購模式。

三種採購模式的具體特點如下：

- 成本主導採購

  客戶從一個框架中選擇一個或多個綜合供應團隊。獲選的團隊必須有能力以協同合作的模式工作，並在預設的成本上限下完成第一個項目，並在其後的項目中逐漸降低成本，同時保持項目的質素。

  在招標過程中，二或三個綜合框架供應團隊將有機會在項目早期與客戶團隊擬定投標價格，使他們能夠運用他們的經驗，創新和降低成本。假設有至少一個團隊能做到低於成本上限，則按照各團隊的商業和實際建議及團隊成員的相對吸引力評分，繼而正式授予項目合同。

  假如無一團隊能夠在可負擔財政預算內交付工作，項目就會讓框架以外的供應商承包。我們的期望是在一個能交付同類型項目而管理良好的架構中、客戶和供應商均十分理解成本的情況下，這種情況不會經常發生。

  如果項目的價格不如預期，則不應該繼續發展。在這種情況下客戶可能需要重新考慮其預算或要求。釐訂一個既實際又有挑戰性的價格，並讓業界供應鏈有能力完成項目，對客戶來說也是一項挑戰。

- 綜合項目保險

  客戶舉辦招標程序以委任一個綜合項目團隊負責完成項目。評分準則可包括評估能力、承擔能力、良好紀錄、成熟行為、消除浪費和低效的建議，以及費用申報等要素。

  獲選的團隊將建立一個既能實現客戶期望成果、又能符合現有成本基準的方案。

  這個模式和現有採購模式的主要分別是採用了一套單一的第三方保證保險，以承擔與項目進行有關的風險。這套保險把現時由客戶和供應鏈成員持有的所有建築相關保險整合為一，同時應對商業風險，承擔任何超出了客戶和承包方（供應鏈的主要成員）透明地分擔的額外支出。

  這個模式通過一連串的途徑，為計劃引入第三方帶來的獨立協助和保證，以確保良好的性價比，並為參與的保險公司取得全面、平衡的商業地位。

  出現超支情況時，這份保險能夠承擔額外的支出至一個指定限額，消除了在團隊中互相推卸責任的責

難文化。支付賠款是基於實際損失而非出於責難。然而，為了確保承保，團隊必須首先準備一份可信的建議書，並由獨立專家的擔保人驗證，以確保商業張力不變，而承保人亦同意可行。

– 二段招標

客戶為單一項目邀請有潛力的團隊成員，或從一個架構中邀請團隊按擬定規格和成本基準競投一個項目。在第一階段數名承建商和顧問團隊憑他們的生產力、能力、穩定性、經驗、供應鏈實力，以及費用（利潤加上公司開銷）爭奪合約。在第二階段，獲勝的承建商和顧問團隊獲委任按開標成本擬備一份能滿足客戶期望成果和成本基準的建議書。

該方法降低行業招標成本，加快人手調動，讓客戶有機會於第二階段結束中標後和正式開始現場工作前，更早與單一的綜合團隊測試設計、成本和風險問題。

這採購模式的關鍵在於承建商 / 分包商有系統的早期參與。這模式在第一階段已為他們的設計和風險分布定下期限，在客戶授權施工前已有固定價格和明確的風險狀況。

試行項目

我們目前為政府實行的試行項目計劃正監控約 20 個工務工程項目，旨在為上述的採購模式作出示範。我們發布案例研究報告，確保中央和地方政府從試行項目中學習，使所有工務工程均採用這些方式提高效率。早期的報告強調節約，並全面審查是否所有共同特點、具體功能和其他如建築資訊模型（BIM）和 Government Soft Landings 等關鍵措施均已推行。他們也強調提高採購效率的重要因素，例如使用框架以建立策略性合作關係並持續改進。詳情請瀏覽：

https://www.gov.uk/government/collections/new-models-of-construction-procurement

結論

建基於 LATHAM 和 EGAN 在 90 年代推行的政府和業界合作措施的《Construction 2025》為英國建築界定立了新的願景。語言和工具在不斷進化，我們視 BIM 為提高效益的主要工具，但我們的基石依然非常清晰：整合和協同工作。

把「建造業」與其投資者、客戶或最終用戶的需求分開討論這個做法現已越趨不當。我們的樓宇、基建和景觀不僅需要規劃、設計和創造，更需要適當的資金和有效的管理，才能在整個建築生命過程中創造價值，最終有效率地停用或重新部署。行業的商業模式需要從通過收入獲利的垂直承包模式，轉變至通過創造價值而獲取酬賞的綜合模式。行業需要刺激創新，消除那些在結構、交易、合同和競爭等方面窒礙其發展的限制。我們需要一套新的能力。財政和資金、BIM、資產管理和協同工作將是整個供應鏈的成功基礎，而追求卓越的價值、個人和企業誠信、信任和尊重他人則是成功的關鍵。凡此種種均必須在 2025 年之前實現。

作者簡介

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Don WARD 先生是英國建造業改革運動的領導人物，亦是各式協同合作的倡導者。他擅長行業改革、供應鏈整合、協同工作、標準借鑑和可持續發展，致力於研究、推行並學習英國和海外建築及基建的最佳作業方式和變革計劃近 30 年。他是英國政府內閣辦公室顧問，也是曼徹斯特商學院 Centre for Infrastructure Development 的執行總監。

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