W117 Performance Information in Construction: 2017 Research Roadmap Report

Foreword: by Dr. Wim Bakens-Secretary General for CIB

The CIB Working Commission W117, "Performance Measurement in Construction," is one of the more innovative and productive research-based commissions in CIB. It focuses on the utilization of performance metrics in the delivery of construction services. The home for W117 is the Performance Based Studies Research Group (PBSRG) at Arizona State University (ASU) in Tempe, Arizona, where W117 and ASU-PBSRG hold their annual Best Value Conference. From its start in 2009, W117 was led by Prof. Dean Kashiwagi (ASU), and his group of innovators (Dr. Kenneth Sullivan, Sylvia Romero, John Savicky and Dr. Jacob Kashiwagi) and co-coordinator, Professor Charles Egbu, (Glasgow Caledonian University). In 2016, W117 was joined by Co-Coordinator Prof. Sicco Santema, (University of Technology, Delft, Netherlands) the visionary who led to the proliferation of the W117 technology in the Netherlands.

W117 aims to change construction procurement and stakeholder organizations worldwide through the use of the information-based Best Value Approach (BVA). As such, it differs from most CIB Commissions that are more science driven, while W117 is more concept and impact driven. It has been one of the most successful CIB Commissions in bridging the gap between the construction industry practice and academic research. It has been prolific in publishing and running research tests with industry partners. W117 and PBSRG have published over 300 papers and generated licensed technology (47 licenses from AZTech, the licensing body of ASU for intellectual property rights). It is the most licensed technology from the most innovative university in the U.S. (as rated by U.S. News and World Report (2016).

W117 is responsible for the development and continuous testing of the following technologies:

1. Best Value Approach (BVA).
2. Best Value (BV) technology.
3. Performance Information Procurement System (PIPS).
4. Performance Information Risk Management System (PIRMS).
5. Information Measurement Theory (IMT) and Kashiwagi Solution Model (KSM).
6. A new project management model based on IMT.
7. A new risk management model that focuses on the risk that the expert vendor does not control.

The activities of WII7 are responsible for the following unique and dominant impacts on the delivery of construction:

1. Rijkswaterstaat, the largest user of construction services in the Netherlands, won the 2012 Dutch Sourcing Award (DSA) for the successful completion of a $1B infrastructure project called "fast-track projects" using BV-PIPS.

2. NEVI, the Dutch procurement professional organization, has licensed the Best Value technology from ASU and has identified the approach as a mainstream approach to the delivery of services, educating and certifying procurement professionals in the delivery of construction and other services.
3. Dutch visionary and author Sicco Santema, and his protégé Jeroen Van de Rijt, published a Best Value Procurement (BVP) Dutch book, using Dutch test cases to show the BVA technology was compliant with European Tender Law (12,000 books sold). Other books (in Dutch) were also published for the contractor community.
4. RISNET, a Dutch risk management association, licensed the Best Value Approach in order to increase the use of the risk-based project management in the construction industry.
5. W117 BVA certification system was developed, which certifies competence of BV professional practitioners.
6. W117 coordinator, Dr. Kenneth Sullivan, introduced the BVA into Canada, resulting in $3M research grants for the delivery of construction services in 25 different universities and government organizations.
7. W117/PBSRG Best Value expert John Savicky, signed a sole source agreement with the National Association of State Procurement Officials (NASPO) and their subsidiary, the Western States Contracting Association (WSCA), to allow all states to utilize the W117/PBSRG technical expertise by "sole source." This has led to tests in 33 different states.
8. Introduction of BV into Malaysia in 2012, into the Project Management Master's Program, led by Dr. Fah Choy Chia at Universiti Tunku Abdul Rahman (UTAR).
9. Introduction of BV into India in 2014 resulting in the noted engineering school, SJCE, adopting the curriculum into their engineering school.
10. Introduction of BVA into Norway in 2014, through the FIR, the construction engineering association. FIR also translated the Dutch book into Norwegian, going public on June 20, 2016, during a three-day event to include the first certification of Best Value professionals in Norway. The first BVA testing occurred in 2016 [with the award made in 2017], and with a minimum of five additional tests scheduled in 2017. The first large BVA certification testing sponsored by W117, occurred in 2017 in Trondheim, Norway. Earlier individual certifications occurred in 2014 and 2016.
11. Introduction of BV into Poland with a three-day conference in Krakow in March 2016, with the publication of the translated Dutch Best Value Procurement (BVP) book into Polish. The first W117 sponsored certification training occurred in April 6, 7th 2017 with the licensed Polish BV Foundation. The next BVA CIB sponsored training will be in October 2017.
12. Introduction activities in Switzerland, Denmark, Finland, Hungary, Germany and Saudi Arabia in 2015 and 2016.

These research efforts have led to the following future research and development opportunities:

1. Development of the language of metrics in the delivery of construction services.
2. The development of a new risk management and project management models.
3. Opportunity to test the sustainability of innovation in traditional environments.
4. Opportunities to test the innovative concepts in different countries.
5. Opportunity to identify and test the sustainability of testing new theoretical concepts in the industry without the traditional extensive academic research literature search and investigations.

W117 has successfully utilized the CIB Platform to impact the construction industry performance worldwide with the information based academic research. Its drive to make a difference is to be applauded and this Research Roadmap (for consultation) is one more example of its high quality and high impact deliverables.

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Remarks by the W117 co-chairs:

The W117 commission is a leader in innovation. It is the first commission to have a very focused goal of implementing academic research/industry testing to impact the construction industry. The research is constantly evolving and impacting the direction, scope and speed of evolution of performance metrics, transparency, mitigation of risk and the improvement of the supply chain stakeholders. However, this is not the only thrust and value of W117. The W117 is looking to change the definition of successful and impactful research from traditional academic/industry

research. It will change what is recognized as valuable and impactful research. This Research Roadmap is the latest document, as of June 2017, and will be continually changed in the coming years. W117 welcomes all other working commissions and industry visionaries to join in the effort towards improving the construction industry.

Towards a CIB W117 Research Roadmap

In 2005, the CIB Program Committee organized TG61, for the purpose of identifying the performance of the construction industry based on performance information or metrics. TG61 produced a report based on a comprehensive literature research on the use of performance metrics in the construction industry. It identified a lack of research based on actual industry research tests (Egbu et. al., 2006). As a recommendation of TG61, the CIB Program Committee established a Working Commission, W117, on the *Use of Performance Information in Construction* in 2009, and appointed Dean Kashiwagi (Arizona State University) and Charles Egbu (Glasgow Caledonian University) as co-chairs. In 2016, Charles Egbu was replaced by Sicco Santema (Delft University of Technology).

W117 Objectives and Scope

The objectives and scope of W117 is to document and explore the potential use of performance information to improve the state of all stakeholders and their organizations in the construction industry supply chain. This includes:

1. To establish W117 as the worldwide center of excellence in both the construction industry and in academic research in the documenting, doing theoretical, prototype testing, implementation research and the testing of performance information to create transparency and the mitigation of risk in the construction and other industries.
2. To identify collaborators who could assist the W117 in the documentation, testing and research of the use and implementation of construction performance information in the industry.
3. To improve supply chain performance and the performance of all stakeholders in the construction industry through research and testing.
4. To advocate the use of performance metrics in the acquisition and delivering of construction work.
5. To advocate for new approaches to performance metrics that improves the construction industry performance.
6. To study different countries and cultures to identify how the use of performance metrics can improve the performance of construction and other services in their respective countries.
7. To document the use, research and testing of performance metrics in the delivery of services in the *Journal for the Advancement of Performance Information & Value*.
8. To quickly and accurately get the W117 research results to the industry and stimulate even more research in the area of performance metrics by utilizing the W117 journal.
9. To apply different approaches of research to validate outcomes from different angles. Approaches include literature search, discussion among the industry and academic

researchers, and analyzing the opinions of individuals interviewed on the concept of using deductive logic and common sense and hypothesis testing. All of which are validated by immediate testing in practice.

W117 Work Program

The W117 Work Program includes:

1. Conduct research on the use of performance information in the construction industry to develop state of the art practices that increase construction performance and value, minimize risk and resolve longstanding issues in the construction industry.
2. Test all concepts in academic research/industry tests, which are led by visionary researchers. The use of research/industry test results to validate new concepts to change the way research is perceived.
3. Publishing a CIB preferred journal to document the use and impact of performance information in the construction industry and quickly disseminate to the industry and research community.
4. Hold annual CIB W117 meeting, to discuss the latest results of research in the use of performance information in construction.
5. Do CIB W117 webinars or post presentations on youtube to proliferate the exposure of the use of performance information concepts in the construction industry.
6. Attend and participate in different international conferences to stimulate expert discussion on the use of performance metrics in the construction industry.
7. Partner with different research groups and industry experts to proliferate research on the use of performance metrics.
8. Educate and run academic/research tests in different countries to the use of performance metrics in the delivery of construction.
9. Hold W117 meetings to assist different countries in implementing performance metrics in the delivering of construction services.
10. Hold meetings with industry stakeholders to help bridge the gap between academic research and industry practices and encourage the industry to sponsor academic research testing on their own projects.
11. Generate research funding to do research in the use of performance metrics in the construction industry.
12. Create partnerships with active research groups and the CIB to self-fund CIB W117 activities and research and can be self-sustainable without CIB funding.

Introduction

The CIB Secretariat has created a CIB Roadmap that will assist the working commissions to create their own roadmaps, to become successful, sustainable, focused on a strategic plan and assist the improvement of the worldwide construction industry, see Figure 1. The CIB research roadmaps provide authoritative guidance and support for national and international research bodies and funding agencies.

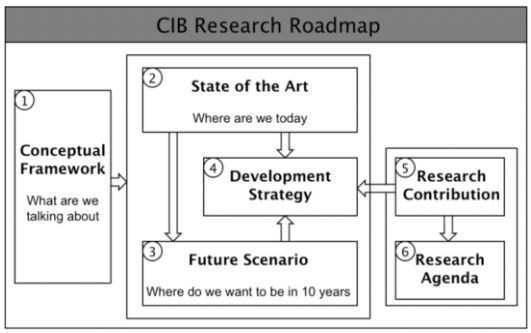

Figure 1: Outline of Research Roadmap

As the illustration indicates, creating a CIB 117 Research Roadmap requires the following questions to be addressed:

1. Conceptual Framework:
   What are we talking about? This question includes the typical: What are the issues, how are these interrelated, what influences all of this, who are the stakeholders, what are the relevant areas of expertise, what are the characteristics of relevant systems, processes, and technologies? This is addressed in the *Conceptual Framework* section.

2. State of the Art:
   Where are we today? This question includes: State of technology, best practices, international variations, perceived problems and the world's leading centers of expertise. The state of the art is elaborated in the section *State of the Art in the Utilization of Performance Information*.

3. Future Scenario:
   Where do we want to be in ten years? The stakeholders' vision is described in section *Future Scenario: Where Do We Want to Be in Ten Years?*

4. Development Strategy:
   This section includes: what is needed in terms of knowledge, information, tools, concepts and applications to enable the respective systems, processes and technologies to be developed over time? These subjects will be described in the section *Development Strategy.*

5. Research Contribution:
   In section *Research Contribution,* we describe how W117 research contributes to the development strategy and what the requirements for research are in order to make that contribution.

6. Research Agenda:
   Section *Research Agenda* concludes with the agenda for W117 research worldwide. That will include areas of science and technology development, required sequences of development, priorities, international cooperation within the research community, cooperation between research and practice.

Conceptual Framework

W117 Research Technology: The Use of Performance Metrics in the Construction Industry

The conceptual framework for TG 61 and W117 was created by co-chair Dean Kashiwagi (Arizona State University) and supported by Charles Egbu (Glasgow Caledonian University) and later, Professor Sicco Santema (Delft University of Technology). Professor Dean Kashiwagi is a researcher in the area of performance metrics, the language of metrics and the use of metrics to simplify and improve the construction industry performance. He has had research test responsibilities for more than 25 years. His expertise is defined by over 300 publications, 1,900 research tests and delivery of $6.6B of services. He also has been involved with education and research testing in 13 countries [United States, Canada, Finland, Botswana, Democratic Republic of the Congo, Netherlands, Malaysia, India, Norway, Poland, Vietnam and China] and 34 states in the United States. This led him to being named as an original co-chair of W117, and resulted in the conceptual framework for W117 research. Professor Charles Egbu gave W117 tremendous support in exposing the performance information technology in the UK academic conferences. Professor Sicco Santema has been the latest visionary to support the worldwide effort.

Co-chair Dean Kashiwagi has gone through multiple cycles of finding new researchers in the area of utilizing performance metrics for the improvement of construction services. The cycles were needed because many of the participating researchers, after a certain time period, did not sustain or receive enough funding in the W117 research area to stay active in this narrow field of W117 research. Dr. Dean has been successful in recruiting new W117 members within the same area of expertise to replace those who moved on to other research areas. The new members are being recruited not only from academia, but from the industry as well, many who are running research tests in different countries. The research tests are continually improving and developing the *technology of performance metrics* (Best Value Approach, language of metrics logic called the Information Measurement Theory, procurement processes, project management processes and risk management processes).

Worldwide construction research was mainly focusing on the documentation of problems. This included the documentation of Key Performance Indexes or KPIs. However, the research community has failed to show how the KPIs increased the performance of construction services. For example, many industries use KPIs but do not know how to apply the metrics to improve construction performance. Each country also has their own perception of the cause of the construction industry non-performance.

In 1993, ASU/PBSRG identified a potential solution. It had the following unique characteristics:

- Based on deductive logic identified as Information Measurement Theory.
- Simplification of the environment and creation of transparency.
- Identification of industry experts who could immediately test the hypothesis.
- PBSRG maintains a high level of control over the industry test.

Issues in the Construction Industry Worldwide

Worldwide, the construction industry has had performance issues for the past 30 years. It appears to be a low performing industry; clients are unhappy and construction projects do not finish on time or on budget and construction companies finish projects at a loss. Over the last 30 years the assertions were validated by numerous landmark studies. The first major study was a breakthrough study conducted in 1994 by Sir Michael Latham (1994), who identified how significant non-performance was attributing to the continued failings within construction in the United Kingdom. He was one of the first researchers to expose that construction non-performance has been existent for the past 30 years. Interestingly, Peter Goff, of the International Project Management Association (IPMA), shares a similar argument by identifying that, despite the hundreds of millions of dollars invested by private enterprises and government to increase education and training of project managers, there has been no major increase in performance to back up its validity (Goff, 2014). In all, Latham identified current business practices of management, direction and control as the causes of an inefficient environment, and non-performance on construction projects (1994).

Due to the continuous efforts of resolving construction non-performance, the industry was still not improving. In 1997, the United Kingdom commissioned John Egan to develop a task force to perform another study on the performance of the industry. Similar to the first study, Egan identified a lack of leadership in business practices and integration of standard processes and teams (Egan, 1998). Although both studies have motivated industry and academia to improve the industry performance, the construction industry has seen minimal improvements moving into the 2000's to present day (Chikuni & Hendrik, 2012; Oyedele et al., 2012; Georgy et al., 2005; Bernstein, 2003).

The construction industry has continued to struggle in the 2000s, though some improvement has been documented. The UK, from 2000 to 2011, saw an increase in customer satisfaction from 63% to 80%, but its projects were still only completing on time 45%, and met budgets 63% of the time (KPI REF). In the U.S., productivity has decreased by 0.8% annually (Adrian, 2001). Construction companies have the second highest failure and bankruptcy rate of 95% (Associated General Contractors, 2006). Over 90% of transportation construction jobs are over budget, and almost 50% of time is wasted on job sites (Lepatner, 2007).

According to a recent Construction Industry Institute (CII) study published in 2015, 2.5% of projects are defined as successful (scope, cost, schedule, and business), 30% of projects completed within 10% of planned cost and schedule, 25 to 50% is wasted due to coordinating labor on a project, and management inefficiency costs owners between $15.6 and $36 billion per year (Lepatner, 2007; PWC, 2009; Yun, 2013).
In 2008, TG61 did a comprehensive literature review of all research efforts worldwide to identify:

1. Research groups who identified the issue of construction nonperformance, and ran academic/industry research tests to confirm their hypothesis.
2. Research groups who ran repeated academic/industry research tests to validate their hypothesis to increase construction performance.

The study filtered through more than 15 million articles and reviewed more than 4,500 articles. The study found only 16 articles with documented performance results. The Best Value Approach (BVA) was one of three construction methods found in those articles, and the Best Value Approach was found in 75% (12 of 16) of the articles (Egbu, et al., 2008; Michael, et. al., 2008). The BVA was identified as the only research concept with repeated performance metrics.

For the past five years, W117 has been attempting to identify all construction delivery systems with documented performance information. W117 has sifted through hundreds of papers, websites, and personal industry contacts, and found similar results to the first study. Thus far, the only approach with documented performance is the BVA and PIPS. (Thomas, and Napolitan, 1995; Odeh, and Battaineh, 2002; Hsieh et al., 2004; Assaf, and Al-Hejji, 2006; Arain, and Pheng, 2006; Lo et al., 2006; Sambasivan, and Soon, 2007; Al-Kharashi, and Skitmore, 2009; Mahamid, et al., 2011; PBSRG, 2016)

In one promising study, Sanvido and Konchar identified that the design-build approach was significantly better. However, five years later, a follow-up and more comprehensive study identified that there was no significant evidence that one approach was better to any of the other approaches (Leicht, 2015; Konchar, 1998).

A conceptual framework was proposed by Kashiwagi (1991) that has remained as the foundation of the efforts of W117 (Figure 2).

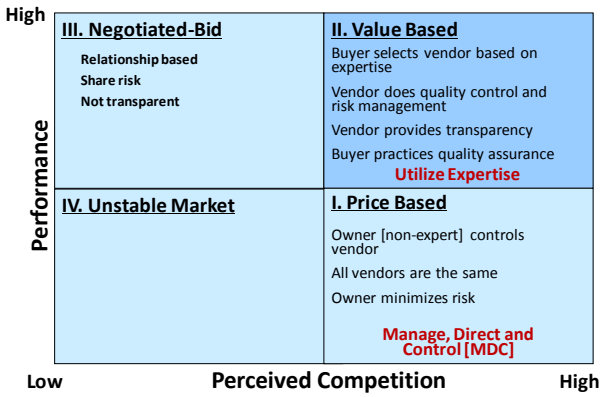

Figure 2: Conceptual framework of the construction industry structure

The Construction Industry Structure has the following proposals:

1. Poor performance is caused by owners using management, direction and control (MDC) to minimize the risk of construction nonperformance.
2. Risk is caused by non-expert stakeholders and not contractors [over 90% of all project cost and time deviation (US Army Medical Command study, State of Minnesota study and Rijkswaterstaat fast track projects)].
3. Risk cannot be transferred by means of contracts.
4. When MDC is utilized to mitigate risk; risk, cost and nonperformance increases.
5. High-performing construction is delivered by utilizing construction expertise instead of MDC.

W117 has proposed the following to the construction management research community and the construction industry based on research test results (Kashiwagi J., 2013; Kashiwagi, D., 2016; PBSRG, 2016):

1. The owner or buyer of construction is one of the biggest sources of risk in the delivery of nonperforming construction.
2. Management, direction and control (MDC) by the owner to minimize the risk of construction nonperformance is a major source of nonperforming construction.
3. The lack of utilization of construction expertise by the owners of construction is a resulting problem.
4. The lack of the quantification of construction problems using performance metrics has resulted in the construction nonperformance being a stubborn and lingering problem.
5. There is confusion in the construction industry on the source of construction nonperformance.

W117 conceptualizes the current problem of construction nonperformance with the following characteristics:

1. The construction academic researchers and industry sees the industry as being too complex and has difficulty simplifying the problem and potential solutions.
2. Because of the lack of understanding of the construction nonperformance, it is very difficult to identify the problem, devise a system/approach to solve the problem, and run tests to validate the proposal.
3. The industry perceives that the problem is a technical problem, and is therefore looking for technical solutions such as BIM to solve their problems. W117 research has identified the problem as a non-technical problem, and more related to the supply chain and humanistic characteristics of the supply chain stakeholders.

W117 proposes to solve the problem by using:

1. Deductive logic, natural laws, transparency and simple concepts.
2. Utilizing expertise to lower cost and improve quality.
3. Creating transparency by creating simplicity using the language of metrics.
4. Creating simplicity by changing the definition of risk as what an expert does not control, changing the project management and risk management model [utilizing a weekly risk report (WRR and Director's Report)].

Test results over the past twenty years have validated many of these concepts. For example:

1. When transparency is created, there a very few disagreements between stakeholders.
2. When an expert has a plan that includes the functions of all stakeholders, the stakeholders do much better in minimizing the risk that they would normally maximize.

3. When performance metrics are used, there is minimal discussion on someone's level of expertise.
4. An expert who knows what they are doing should always have a lower price than a non-expert. Therefore, the objective is to hire an expert who can lower project costs.

A study was performed, identifying that the Best Value PIPS was the only delivery system with the concept of no-control or minimizing management, direction, and control (Kashiwagi J., 2013). This research also documented the potential impact that implementing the concept of no-control could have on the delivery of construction services (Kashiwagi J., 2013). The study involved 31 construction and non-construction services, among 5 different major buyers in the U.S., comparing the performance of the project when delivered with the Best Value no-control concept and with the traditional management, direction and control techniques (see Table 1). It found the following:

- Cost of services decreased on average by 31%.
- Suppliers were able to offer the buyer 38.5% more value, totaling up to $72.76M.
- The average customer satisfaction of the service being provided increased by 4.59 points on a 1-10 scale (134% greater than the traditional customer satisfaction rating).

Overall Comparison

Criteria	Traditional	Best Value
# of Outsourced Services	31	31
Cost of Services	$274,480,342	$189,001,943.00
Added Value	-	$72,762,248.60
Average Customer Satisfaction	3.43	8.02

State of the Art in the Utilization of Performance Information

PBSRG, Kashiwagi Solution Model (KSM) Inc., W117, TU-Delft and the JSS, have been developing the use of performance information in the construction industry for the past 25 years. The state of the art practices, which are the most licensed technology developed at Arizona State University (licensed by Arizona Tech, the licensing arm of Arizona State University) include:

1. Using the Best Value Approach (BVA) to deliver construction services which results in a very high level of performance. This includes the use of the Performance Information Procurement System (PIPS) and the use of the Performance Information Risk Management System (PIRMS). PIPS has three major phases: Selection, Clarification and Execution. PIRMS uses the low-bid award system as the selection phase, but the clarification and execution phases are identical.
2. The use of the language of metrics to create transparency. The language of metrics minimizes misunderstandings through unified coding.

3. The identification that risk is caused by non-expert stakeholders. Risk cannot be passed. Risk has to be mitigated. Performance metrics are used to explain risk to non-experts, thus leading to risk mitigation.
4. The use of Information Measurement Theory (IMT) and the Kashiwagi Solution Model (KSM) to understand human nature, predict future human behavior and utilize these technologies in the selection and alignment of human resources in construction services.
5. The optimization of construction resources using a structure that assists in the optimization of expertise by creating an environment of transparency.
6. Continuous learning from tests and new versions of the methodology. The cycle of learning keeps speeding up as more countries and academics/practitioners are joining the effort.

The W117 sponsored journal captures the latest developments in the use of performance information in the construction and other industries. W117 also keeps a database of published papers in the area of performance information. The W117 committee members are constantly experimenting by using the BVA in new environments (including different industries and countries).

The technology of the Best Value Approach (BVA) is licensed by Arizona State University to 52 organizations and is used by supply chain stakeholders (owners, designers/engineers, facility managers, contractors, subcontractors and material suppliers) and academic researchers. The BVA has led to a new project management model including a new risk management approach (risk can only be mitigated and not transferred) and a new leadership approach which utilizes the entire supply chain.

The CIB W117 Performance Information in Construction working group, is led by the creator and founder of the BVA and includes the worldwide experts in both academic research and construction industry practice in the area of using performance metrics in construction projects. W117 is constantly looking for new countries and contributors (both in practice and in academia) who understand the Information Measurement Theory (IMT) and urge them to participate with W117.

The case of the Netherlands adoption of the BVA took five years. These years included the usage of BVA by Rijkswaterstaat on the $1B U.S. fast track road construction projects, the acceptance of BVA by NEVI (Dutch professional procurement group) and the publishing of the first Dutch Best Value Procurement (BVP) book (by Jeroen van de Rijt and Sicco Santema). This book showed that the methodology was compliant with the European Tender Law. Up to 2016, the book is in its third edition and more than 12,000 copies of that book have been sold in the Netherlands. As an example of continuous development, the fourth edition of the book will be published in 2017, adopting all the latest insights.

In the Netherlands, now that the BVA has great exposure, the challenge becomes:

1. How to ensure that the new paradigm is being understood by new practitioners.
2. To ensure proper documentation.

3. To ensure that the contractors/vendors understand the BVA.
4. How to educate the supply chain fast enough to keep up with the demand of Best Value services.

W117 is now faced with the challenge of how to proliferate the BVA in the other European countries. Currently BVA has been moved into Norway and Poland, having the Dutch book translated into Norwegian and Polish. The BVA is currently being exposed to Switzerland, Denmark, Finland and Germany.

The proliferation into other European countries is through the Dutch and European professional engineering groups (in construction) who have observed that their expertise is not being utilized by owners. The Dutch Rijkswaterstaat organization is also exposing the BVA to other infrastructure organizations of other European countries. Also, other organizations exposed to the BVA in the Netherlands, are moving it to other European countries where they do business.

Future Scenario: Where Do We Want to Be in Ten Years?

In 10 years, the W117 BVA technology will be known and practiced in 10 major construction industries worldwide, next to the United States and the Netherlands. The technology has the potential to change national procurement models, project management models and risk management models. The Information Measurement Theory or the language of metrics also has the capability to change the traditional leadership models.

In these countries, the risk management model will change from the traditional model, which transfers risk by legal contracts, to a risk mitigation model, which identifies risk as what an expert contractor cannot control. The BVA will also mitigate risk by creating transparency, simplicity and utilizing performance metrics.

The successful research model of the future will be a mixed-methods model based on deductive logic and utilizing case studies. The research model will create change by showing dominant improvement in lowering project costs, increase profit margins and projects that are delivered on time and on budget. The approach is not technical in nature, making the W117 technology able to be applied to all industries.

Stakeholder's Vision of the Future

The stakeholders of the W117 technology are the stakeholders in the entire supply chain. Their vision is simple: lower project costs, higher project value, higher performance and higher profits. The success of W117 is that the BVA technology being developed is simple, easy to understand at a very high leadership level, but never the less, counterintuitive. The major requirements of the research effort is to document the technology in a way that fits the culture of the country. The results of the technology are so dominant, that the newer countries are adopting the approach with very few modifications. Education and training are the most critical challenges.

The following points summarize W117's development strategy and research contribution and development:

1. Development Strategy: What is needed in terms of knowledge, information, tools, concepts and applications to enable the respective systems, processes and technologies to support the BVA?

   The basic technology of the BVA performance information is already developed. There are two major stages of research development in every country. The first stage is the identification of expert "information workers" who understand the change of paradigm. The second stage of development is the running of academic/industry research tests. In each stage the following tasks have to be completed. First the communication of the technology, then the education of stakeholders, the acceptance of the change of paradigm and the running of the industry tests. The technology shall be modified slightly to accommodate the culture and understanding of the stakeholders.

   Before either stage can be successfully completed, tasks such as the translation of the English text into the local language and education sessions must be completed. The BVA has already been translated into Dutch, Norwegian, Polish and Arabic languages.

2. Research Contribution: How can research contribute to such development strategy? What are the requirements for research to make that contribution?

   W117 is unique in that it is led by the creator of the BVA and has the most expert BVA experts in the world. The W117 research and journal publication is the mechanism in proliferating the information technology. As more and more countries test the new approach, the documentation and database of results will optimize the future implementations, the information based technology, and increase the capability of the information based technology to be more robust and the identification of any cultural constraints. Never before in construction management research has a new paradigm utilized simplicity, performance metrics, transparency and the utilization of expertise to dominantly improve quality, reduce project cost and improve expert contractor profit margins. As discussed earlier, because the majority of academic researchers are involved in traditional research, a major contribution of W117 will be the changing of the research paradigm from the analysis of survey results to academic research/industry tests. The research publications will impact the change of paradigm in the areas of construction management, risk management and project management.

3. Research Agenda: What is the agenda for research worldwide?

   The research agenda of W117 includes simplification of the logic (IMT), translating the IMT into different languages, running tests in different cultures and environments, and implementing the logic to improve construction performance.

The W117 journal is being used to get the developments, results and new concepts to the industry stakeholders and researchers as quickly as possible. The journal will maximize the importance of peer review by academic and industry experts, and maximize the importance of the academic/industry test results. W117 research agenda is to proliferate the technology in as many countries and cultures as possible. W117 is always looking for innovative implementations of the BVA.

The research agenda includes the following innovations:

a. The W117 journal publications must receive wider dissemination in the academic world through the use of another internet system.
b. Changing the paradigm of the importance of academic research/industry testing instead of literature search and the analysis of survey results.
c. Moving all research results under the W117 umbrella and not a specific university.
d. Creating a full time W117 core team that will be more efficient in coordinating all W117 activities. Professor Kashiwagi will be responsible for organizing this team that will be responsible for the database of documentation, journal, secondary internet dissemination system and continued worldwide presentations.

Development Strategy

The CIB W117 development strategy is quite ambitious. The development will take place in three dimensions:

1. Knowledge.
2. Tools and applications.
3. Geographically.

These dimensions are set out in Figure 3.

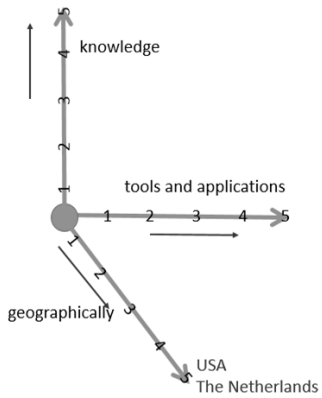

Figure 3: Dimensions of the W117 development strategy.

The knowledge on Value Management in Construction Performance Measurement is constantly being developed. Practitioners are constantly using the technology of the language of metrics and performance metrics. Practitioners are annually getting certified and running best value projects. The key to the BVA to all stakeholders is continuous improvement.

In the tools and application dimension, we use the technology that is a part of the "Information Measurement Theory" (IMT) which is the foundation for the Best Value Approach (BVA). As more and more areas of services are starting to use BVA, additional tools and applications will automatically develop.

The current BVA certification system shows that stakeholder participants have room for growth. Research can track the participant's performance metrics and improve a participant's chance for greater understanding.

The geographical dimension will develop through 'natural growth'. Great progress has been made in the USA, Canada and The Netherlands. W117 can now assist the movement into other countries. In Europe BVA has been introduced in Poland and Norway (Dutch book translated), and presentations have been given in Sweden, Finland, Denmark, Germany, Switzerland, Czech Republic, Hungary and the UK. A major effort is now happening in Saudi Arabia.

The aim of the geographical development is to find a platform that is willing to pick up BVA in the industry from both academia and practice (consulting, purchasing associations, association of engineers) to create a national body that can bring BVA further. This includes the basic materials in the mother language of that countries, licensed from ASU.

All the advancements will be published in the CIB/PBSRG journal.

Research Contribution

In the previous section we illustrated our development strategy. CIB W117 research is clearly contributing to that, mostly on the knowledge, tool and applications dimensions. The developed knowledge will also constantly be tested in practice.

Below we make some short remarks on the research contributions.

1. Opposite to government funded research (l'art pour l'art), resulting in reports and propositions, we propose to actively research practice in order to come up with solutions for the construction industry. Practical, applied research, resulting in applicable tools. One of the cornerstones of that research is construction practice itself, wanting the solutions and improvements to their ineffectiveness and inefficiency.
2. This means that we will use common academic research instruments like literature search, survey of industry perceptions, and case studies. Next to that we use every method that is needed to come up with practical knowledge and tools.

Obviously, we will report on these in publications, which are a means of communication, not a goal in itself.
3. Through our academic research community in construction we want to make things simple.
4. We will use systems like the deductive logic approach with natural laws of reality such as gravity and combustion that have no exceptions.
5. Successful knowledge and tools will continuously be tested in order to prove over and over their value for the construction industry. It is not the knowledge and tools themselves that have to proof their value, it is the acceptance by the construction industry's practitioners that we are aiming for.
6. We will use a peer review system for our journal based on these practitioners.

The core technology of the W117 is the Best Value Approach (BVA) and Information Measurement Theory (IMT). It is dependent upon metrics and the language of metrics in different processes to improve efficiency and effectiveness of the construction industry. These areas include: project management, risk management, procurement processes, communication between stakeholders and in the research that identifies the success or failure of hypothesis. The Stakeholders include, the entire supply chain of the delivery of construction services: designers, owners and all their representatives, regulatory groups, project managers, procurement personnel, lawyers, general contractors, subcontractors and material suppliers.

KSM, JSS and TU-Delft use their own funds and the available time of construction practitioners to do research. The W117 journal documentation of academic research/industry tests, and the number of new industry/country implementations will drive the research validity.

This different approach, new paradigm of industry testing and immediate results was recognized by CIB secretariat Wim Bakens in 2007, and led to the CIB general board approving a TG61 task group. The TG61 final report validated PBSRG and TU-Delft hypothesis, and led to the general board approving a new working commission W117.

Research Agenda

This section concludes with the agenda for W117 research in the construction industry worldwide. As previously stated in the Work Program, this includes:

1. Creating a CIB preferred journal to document the use of performance information in the construction industry and to publish research results for the practitioners in the construction industry, in order to improve effectiveness and efficiency.
2. Hold an annual CIB W117 meeting, to present and discuss the latest results of research in the use of performance information in the construction industry.
3. Do CIB W117 webinars to proliferate the exposure of the use of performance information in the construction industry.
4. Attend and participate in different international conferences to stimulate expert discussion on the use of performance metrics in the construction industry.

5. Conduct research on the use of performance information in the construction industry to develop state of the art practices in the construction industry. The agenda is set by practitioners that are willing to participate in the research.
6. Partner with different research groups to proliferate research on the use of performance information.
7. Expose different countries to the use of performance information in the delivery of construction.
8. Hold W117 meetings to assist different countries in implementing performance information in the delivering of construction services.
9. Hold meetings to help bridge the gap between academic research and industry practices.
10. Generate research funding (from practice) to do research in the use of performance metrics in the construction industry.
11. Create partnerships with active research and the CIB to self-fund CIB W117 activities and research, to be self-sustainable without CIB funding.
12. Have PhD's start their work at both PBSRG, TU-Delft and other W117 research-based universities. Have MSC students do their graduation projects on the use of BVA in the construction industry.

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