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Independent Project Analysis, Inc.
Program Planning & Project
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10 July 2015

Mrs Jane Prentice MP
Committee Chair
House of Representatives Standing Committee on Infrastructure and Communications
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Cc: Bill Pender
Inquiry Secretary
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Dear Mrs Prentice,

RE: House of Representatives Standing Committee on Infrastructure and Communications Inquiry into the role of smart ICT in the Design and Planning of Infrastructure - *Independent Project Analysis (IPA) Submission*

INTRODUCTION

Independent Project Analysis Inc (IPA) is pleased to respond to the House Standing Committee on Infrastructure and Communication inquiry into the role of smart information and communication technology (ICT) in the design and planning of infrastructure.

Our submission discusses the role of smart ICT in supporting the implementation of Best Practices for the development and execution of large infrastructure projects. This submission broadly spans the following key elements of the inquiry's terms of reference:

- *New capabilities smart ICT will provide*
- *Productivity benefits of smart ICT*
- *Best Practices in the use of smart ICT in the design and planning of infrastructure*

IPA has, for more than 27 years, evaluated the performance and effectiveness of thousands of projects and has developed a comprehensive understanding of the drivers of success and failure of industrial megaprojects[1] and large infrastructure projects.

IPA defines project management as the science of planning (*information development*) combined with the art of reacting to surprise (*organisation effectiveness and management of risk)* and advocates a series of Best Practices as the foundations for effective project development. The management of the quality and flow of information within these practices greatly affects decision making, which, in turn, influences the project's success. Our research shows that large projects' poor performance is primarily due to failures in information generation, flow, and consumption. Therefore, the real benefit of using smart ICT is in managing the information needed to support implementing Best Practices.

Various studies show that both private and public proponents of large construction projects have largely been slow to adopt new information technologies. ICT is frequently

[1] Generally defined as any project with a total capital cost of more than $1 billion (U.S. dollars), although cost is not the key criterion. Complexity determines how difficult the project is and makes it a megaproject.

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deployed purely for monitoring and observing and therefore plays a passive role in managing large projects. There is scope for smart ICT to be more effective and in a more proactive capacity. For example, smart ICT systems can be set up so that real time data are readily available, to enable the project sponsor and management team to rapidly respond to deviations from the plans.

Smart ICT can enable measuring project effectiveness including governance and outcomes. By acquiring critical data and selected performance indicators at all project phases, inputs can be linked to outcomes and key lessons learned can be captured. Critical metrics and performance parameters can then be benchmarked against historical performance and industry Best Practices. Plans and actions can then be implemented to improve productivity and future project performance.

The Productivity Commission's inquiry into the performance of infrastructure projects found that data problems limit analysis and benchmarking. Using smart ICT can deliver a coordinated and coherent data collection process to overcome these limitations. Using smart ICT in conjunction with Best Practices for governance and development can promote better decision making in the selection, definition, and delivery of public infrastructure projects. These improvements will go a long way towards addressing Australia's infrastructure challenges.

WHO IS INDEPENDENT PROJECT ANALYSIS INC

IPA is the preeminent consultancy in capital project evaluation and project system benchmarking and has become the industry leader in quantitative analysis of project management systems. The largest oil companies, chemical producers, pharmaceutical companies, minerals and mining companies, and consumer products manufacturers improve their capital project delivery systems using IPA's consulting and project management training services. IPA improves the competitiveness of our clients through quantitative benchmarking that enables more effective use of capital in their businesses. It is our mission and unique competence to conduct research into the functioning of capital projects and project systems, and to apply the results of that research to help our customers create and use capital assets more efficiently.

Since its founding in 1987, IPA has performed over 17,000 project readiness reviews for over 400 companies and governments. IPA regularly works with industry leaders in the resources sector. For many of these organisations, an IPA due diligence review is part of their governance process to insure a project is ready to advance into execution. In addition, IPA has conducted hundreds of research studies into capital project systems of numerous industries in over 20 years of work.

The Performance of Megaprojects

IPA's comprehensive research into the performance of more than 500 megaprojects across a wide range industry sectors found that more than two thirds failed to meet their objectives. A project was deemed to be a *failure* if: (1) cost growth or schedule slip was greater than 25 percent, (2) if the project had severe and continuing operational problems into year 2 of production, or (3) if the project's total cost was 25 percent higher than similar industry projects or schedule competitiveness was 50 percent poorer than similar industry projects. On this basis, almost two-thirds (65 percent) of the megaprojects studied were failures.

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In his book on industrial megaprojects[2], IPA founder, President and CEO, Ed Merrow, makes the point that the fragility of a project increases significantly with project size and that megaprojects are either successful or "they tend to fall apart". Furthermore, the amount of effort needed to set mega projects up for success is disproportionately higher than for example a typical $100 million project.

An IPA study[3] on the performance of Australian projects, prepared for the Business Council of Australia, found that technically complex projects executed in Australia across all industry sectors did not fare any better. The study found that large projects in Australia have a poor performance record with a failure rate of over 75 percent.

Research into the performance of Australia's infrastructure projects cited in the public domain has shown that their performance is analogous if not significantly worse. Various reviews have found the prevalence of poor governance, inadequate project selection, and planning practices are the main factors undermining the performance of infrastructure projects and, in turn, Australia's infrastructure needs.

IPA's research has shown that successfully delivered megaprojects were consistently developed well and executed with discipline—in other words with very few or no late changes to the original scope. A key enabler of this success, one that is almost unique to complex megaprojects and large infrastructure projects, is the need to assess and then shape the opportunity into a reasonably stable platform from which to manage the project.

Shaping is about subjecting the opportunity (infrastructure need) through enough scrutiny to ensure that all implications in terms of risks, resources, reputation and preoccupation are understood (Merrow).

AN INFORMATION PERSPECTIVE ON THE DEVELOPMENT OF PROJECTS

Based on the conventional linear concept of project development and execution, about two-thirds of the project cycle is spent producing, using, and moving information from one information producer/consumer to another. Until the start of construction (fabrication, installation of new material, or modification of existing facilities), the majority of project work is defining the scope, developing the basic design, estimating the cost and schedule durations, and completing the execution plans. All these major areas of project development involve the production, consumption, and flow of information.

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[2] Edward W Merrow, 2011. *Industrial Megaprojects: Concepts, Strategies, and Practices for Success*, Hoboken, New Jersey; John Wiley and Sons Inc.

[3] Rob Young, *The Performance of Australian Industrial Projects,* **Report** to Business Council of Australia, IPA, May 2012.

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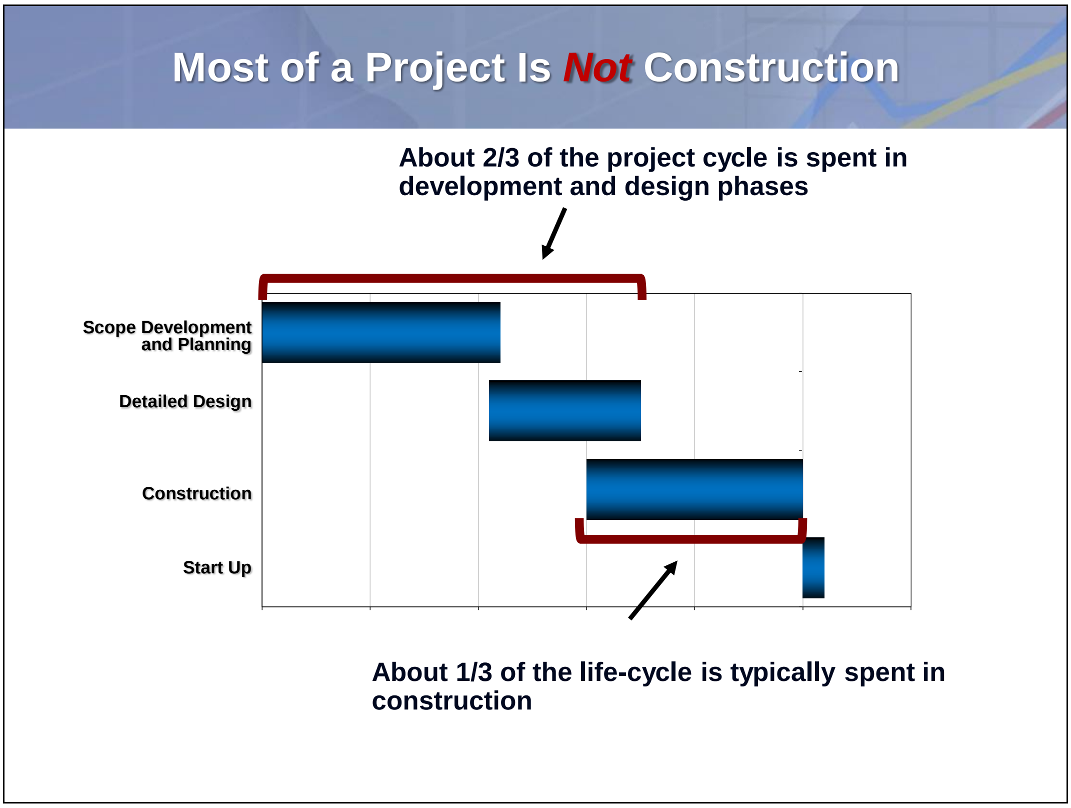

The development and planning phases, or Front-End Loading (FEL), can account for up to 40 percent of a project's cycle time duration and consume between 10 to 15 percent of total project costs. Two major processes must support the development of FEL: ***basic data development*** and the ***opportunity shaping process***.

- The ***Basic Data*** consist of all information underpinning the design; the Basic Data are the project's scientific foundation and the underlying physical and environmental conditions
- The ***Shaping Data stream*** consists of all business objectives and commercial and contextual information on which the project economics depend
- The ***Project Data stream*** consists of the scope and front-end engineering design data, the detailed design, the basis for all materials procurement, and the execution strategies and plans

Together, these processes comprise the major information streams whose relative importance varies with the complexity and circumstances of the development. For large infrastructure projects, the timely completion of these activity streams is critical if the project is to be successful.

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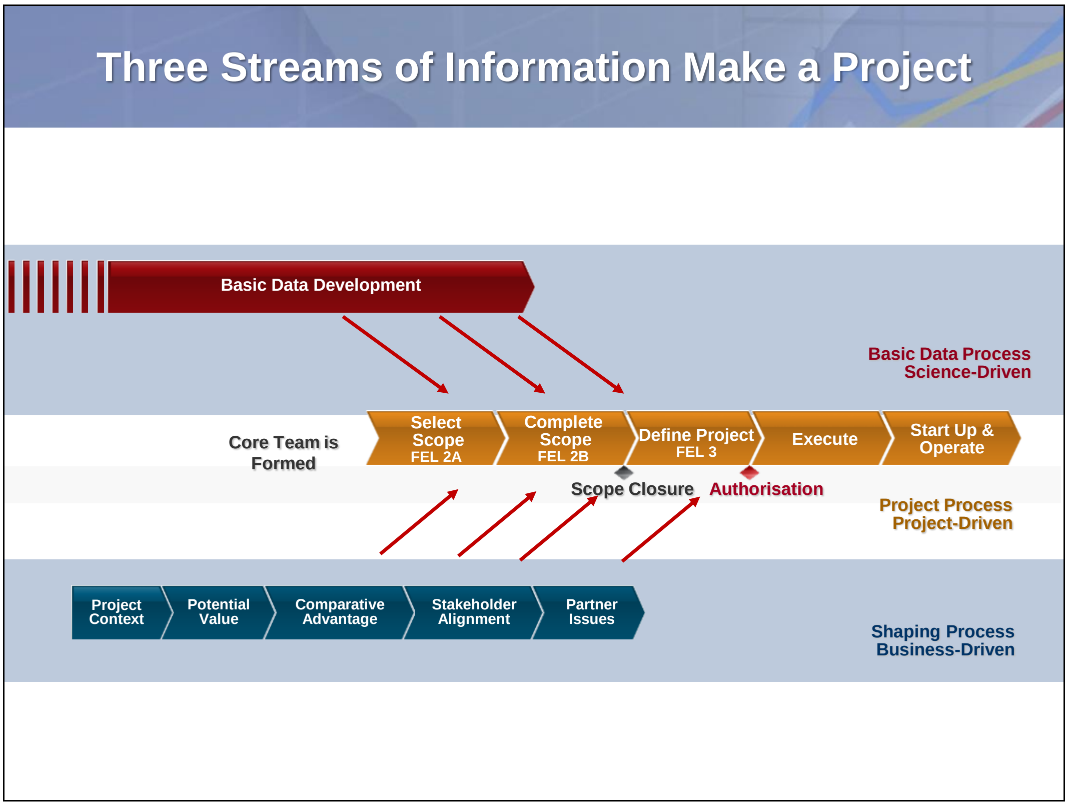

Errors, omissions, or tardiness in any element of any of the three streams will create inefficiencies resulting in added cost, extended schedules, and/or end-use shortfalls. In large projects, information errors can often lead to outright project failure. Information management during this phase via smart ICT implementation is a significant area of opportunity for planning and design improvements.

THE USE OF ICT IN PROJECT SHAPING AND DEVELOPMENT

Below we describe the major components of the three project development information streams. We also list elements within each stream where smart ICT can be used to acquire data which are critical for the development of the overall project.

Opportunity Shaping

During the opportunity shaping process, the lead sponsor—in this case the relevant authority pursuing the infrastructure development—evaluates all necessary attributes of the development so that the acquired value is appropriately distributed to all stakeholders and end users.

IPA's research shows that most organisations lack a coherent, documented process for venture shaping, therefore fostering an environment where data limitations are common, mistakes are easily made, and poor decisions are allowed to dictate the project's progress. Attempts to push forward without shaping the project almost always result in abandonment before sanction or in failure if the project is allowed to proceed. Adopting applicable smart ICT tools and infrastructure to support the key components of the shaping process can deliver significant benefits to the sponsor organisation. The key outcome from adopting effective smart ICT tools is understanding how the shaping process was planned, managed, and

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executed, while critical lessons learned are considered for the next infrastructure development.

The table below shows the five key steps that comprise the shaping process and the key data development areas that can be supported by smart ICT tools and processes:

Key Shaping Process Steps	**Key Data Development Areas Supported by Smart ICT Implementation**
Project Context	• Physical location and remoteness characteristics • Nature and perceived value of the physical environment • Regulatory requirements • Public perception through history of previous infrastructure developments in region • Community consultation and applicable cultural aspects • Labour availability and quality, industrial project activity, and competing influences
Potential Value	• Early economic/social benefit assessment • Characterising the endowment versus context measures • Exit criteria
Comparative Advantage	• Understanding the comparative advantage of the lead sponsor • Quantifying the shape of the infrastructure portfolio and the project's position and fit within the portfolio
Stakeholder Alignment	• Database of all direct and indirect stakeholders (community, local government, local businesses, and end users) • Stakeholder approval requirements • Stakeholder communication requirements
Project Governance	• Project development and approval process mapping • Partner assurance and governance requirements • Independent review requirements, effectiveness, terms of reference • Partner approval requirements

Basic Data Development

Basic Data comprise the set of parameters and information that govern a project's design. For large projects, a large number of different functional groups may be involved in acquiring and developing all required data, and the effort to complete Basic Data may require years of work. As such, without an effective Basic Data management system and appropriate accountability, poor data quality and key data omissions may remain undetected for the remainder of the project's development resulting in costly late changes and undesirable delays. Areas pertinent to Basic Data development that would benefit from implementing smart ICT tools and infrastructure include:

- Identifying Basic Data sources and applicable design standards
- Developing Basic Data quality management protocols
- Developing relevant Basic Data databases
- Developing Basic Data protocols or checklists
- Developing Basic Data interface management framework

Front-End Loading

FEL is the process of translating the opportunity (infrastructure need) into actual project scope, and it is highly integrated with elements from the shaping and Basic Data development

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processes. Scope selection during the early stages of FEL is governed by the Basic Data (technical requirements) and influenced by the shaping process (established decision criteria). Simply put, FEL is the process of defining what will be done, how it will be done, who will do it, when it will be done, and what resources will be needed. Key to the success of large projects is the timely completion of core processes. The late arrival of Basic Data and problems during shaping significantly degrade the quality of the FEL effort.

The three phases of FEL and the key data development areas that can be supported by smart ICT tools and processes are shown below:

FEL Phase	Key Data Development Areas Supported by Smart ICT Implementation
Scope Selection (FEL 2A)	• Early economic/social benefit assessment • Sponsor and end user objectives • Quantifiable performance trade-offs • Governance, Assurance, and Gatekeeping criteria and requirements • Project Organisation – Development Phase • Decision making criteria for each considered alternative option • Performance measurement indicators or KPIs for each considered alternative option and for overall development • Technical expertise requirements • Project risk framework and risk management • New technology data requirements • Basic design requirements • Cost and schedule parameters for each considered option • Total Scope Development Phase cost, schedule, and resourcing requirements
Scope Completion (FEL 2B)	• Updated economic/social benefit assessment • Closure of shaping process – quantification of applicable deliverables • Closure of Basic Data – quantification of applicable deliverables • Scope closure requirements
Planning to Execute (FEL 3)	• Project Organisation – Execution Phase • Basic design packages • Work packages and work breakdown structure • Cost estimate and risk simulation (range analysis) • Schedule development and risk simulation (range analysis) • Project control systems and requirements • Final economic/social benefit assessment • Independent review requirements • Development Lessons Learned database

CONTROL OF EXECUTION RISK

The downward productivity spiral

Large complex projects are made up of many thousands of activities often executed in parallel and with many interdependencies. This complexity contributes to a key vulnerability of these large projects—*fragility*.

The larger and more complicated the project, the more likely it is that inadequacies, mistakes, or omissions will occur in an early phase. Furthermore, for large complex projects, it is more likely for problems to compound with the ultimate result that productivity becomes very poor and costs escalate rapidly. For example, a major late change on a complex $1 billion

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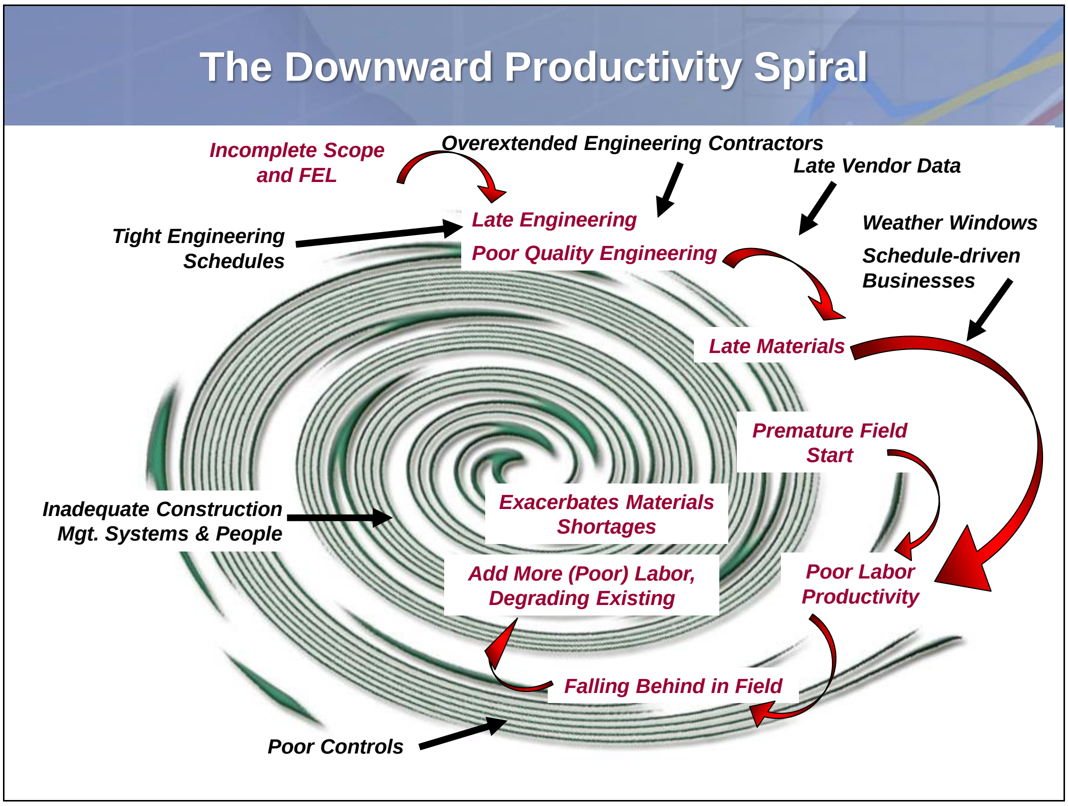
project could result in costs increasing by 30 percent because of the domino effect of late changes through the project whereas a major change to a $1 million project does not have the same effect because there are fewer interdependencies and the effect of the change can be contained.



Construction productivity is a measure of the construction effectiveness, and it is influenced by many factors in the supply chain, most of which precede the start of construction. Poor field productivity is therefore mostly a derivative problem, not a primary one. IPA's studies show that the most serious problem facing projects in the process industries is timely and accurate engineering. IPA's data show that since the onset of the Global Financial Crisis, every measure of engineering quality such as error rate, field engineering adequacy, and engineering slip has declined. Slip in engineering is now approaching an average of 40 percent on projects large and small.

Engineering delays are common symptoms of early productivity problems. Late engineering design means material procurement is late and out of sequence for construction. If construction begins as planned, the quality and quantity of construction design packages will be inadequate resulting in construction inefficiencies and re-work. IPA's research shows that this process has contributed to a 20 percent loss of productivity in capital projects over the past 12 years.

Effective Project Controls

For projects that are well defined, execution is about maintaining the value that was created at the end of the development phase. For poorly defined projects, execution is about containing damage and minimising erosion of value. Therefore, effective project control processes are needed to ensure execution is managed as planned. These processes must be established during the project's early development phases, and one essential element of

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planning how to control the project is to establish the project management information and communication technology system and approach.

The key Best Practices for effective project control and the key data development areas that can be supported by smart ICT tools and processes are shown below:

Project Control Best Practices	**Key Data Development Areas Supported by Smart ICT Implementation**
Estimating for Control	• Cost estimating and scheduling methodology • Detail for each cost category • Degree of cost and schedule integration • Estimating validation and review process • Extent of estimate review and quantitative validation • Establishing a basis for progress measurement • Extent that estimate supports physical progressing • Appropriateness of work breakdown for each cost category
Planning for Control	• Project control plans • Design and scope change management plans • Integration of owner and contractor plans • Reporting of progress and status • Frequency that project progress and status will be reported • Detail of progress reporting planned for each cost category • Independent project control functions

CONCLUSIONS

The performance of large complex engineering and construction projects, including infrastructure developments, has been poor and global project productivity is declining. Doing nothing is not an option. The successful development of these projects relies primarily on the identification, generation, and dissemination of quality information needed to shape an idea or need into a project and turn it into a value adding asset.

The benefits of implementing smart information and communication technology for the development, planning, and design of infrastructure projects can deliver significant productivity gains, particularly when Best Practices are adopted. Key data and associated metrics acquired through effective use of ICT tools and systems can be used to improve governance for future infrastructure developments through performance measurement and benchmarking.

Yours sincerely,

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Director IPA Australia – Asia Pacific

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