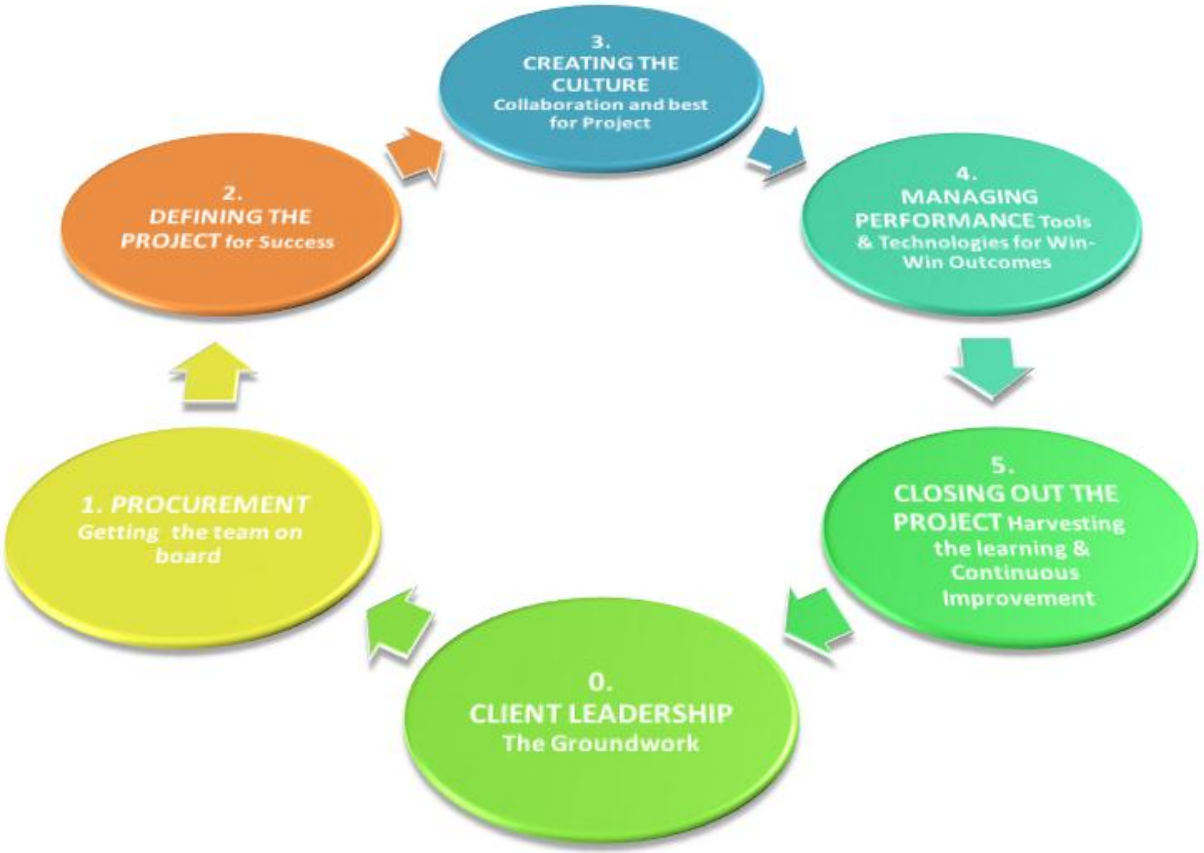
The Productivity Case Study Report

Evidence of Drivers (and Inhibitors) of Productivity



CONSTRUCTING EXCELLENCE IN NEW ZEALAND

BUILDING AND CONSTRUCTION PRODUCTIVITY PARTNERSHIP

September 2012

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1 Foreword

In 1913, Henry Ford built a moving car assembly line for $3,500.00 and immediately effected a 60% to 70% improvement in the productivity of his workforce. The production cost savings were significant and provided a handsome return. However, this benefit was dwarfed by that resulting from improved supply chain integration. Component inventories were slashed and the savings resulting from this alone trivialised the initial investment.

Forty years later, Taiichi Ohno, Toyota's technical chief, looked to Detroit to learn the secrets of high volume steel panel pressing. He saw large numbers of presses stamping long runs of identical parts. When necessary to change the part being pressed on one machine, it took a team of skilled die setters a full day to change the dies. There was an incentive to maximise the size of runs to build inventory and to install enough presses to avoid frequent changes.

Ohno was impressed with what he saw in Detroit but like all post-war Japanese industrialists didn't have the capital to tool up on that scale. He set to work and within 18 months had perfected a system where dies could be changed in 2 to 3 minutes by workers with only assembly line skills. Again, direct labour cost savings alone provided the necessary investment return but capital utilisation and inventory reduction benefits were many times larger.

Why would we look to the auto industry when seeking to raise productivity around the New Zealand built environment? The answer is simply that the principles around efficiency of any project or production process are the same. The auto industry just happens to provide some of the most graphic insights.

We can see from the Ford and Toyota experiences that:

- Productivity can be measured on a range of levels and it is likely that improvements made on one level will have a much wider impact than we might initially anticipate.
- Smoothing of the process and integration of its component parts is fundamental to improving productivity.
- Productivity gains require a culture of continuous improvement and rising expectations.
- The potential for productivity gains is theoretically limitless.
- Productivity improvement requires high level ownership and leadership.

In the course of preparing this report we have talked to a wide range of highly skilled sector practitioners. This has been a very enjoyable experience and has left us in no doubt that there is a will to build on past successes and to learn from the less successful experiences. We also saw plenty of evidence that the experiences of Henry Ford and Taiichi Ohno are universally applicable.

Every project we examined provided important insights into what drives productivity in the sector and our objective has been to draw these together into a productivity best practice model against which Project Sponsors, Clients, Professional Services providers and the Construction supply chain can measure their practices.

As you commence your consideration of our findings, we leave you with this slightly irreverent thought. The Aerobus A380, the world's largest commercial airliner, is assembled in France where the fuselage is made.

Its wings are made in the United Kingdom and shipped across the English Channel. The mating surfaces consist of complex compound curves and there are invariably no assembly problems. If this is possible, then why in the bespoke housing market in New Zealand is it common practice to have the Aluminium joiner site measure window openings already dimensioned on drawings before the windows can be manufactured?

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2 Executive Summary

The objective of this report was to examine 12 selected New Zealand Construction sector 'Pathfinder' projects, interview the respective Clients and members of their Professional Services and Construction supply chains and analyse the results with the following objectives:

1. Identify common themes, processes and approaches that have delivered productivity improvements.
2. From these, identify the most common and universally applicable opportunities for driving productivity improvement and where these are in the life-cycle of a project.
3. Make recommendations on future steps based on the knowledge gained in this research.

A broad range of projects were selected and around 30 Sector practitioners interviewed. As results were distilled, a framework which assisted meaningful grouping and consideration of productivity drivers emerged.

All interviews initially focussed on project success. Without exception interviewees agreed that their projects were successful and readily listed the primary success factors.

As the interviews changed focus from success to productivity, the ability to differentiate between the two concepts became difficult for many. It became clear that sector understanding of productivity remains largely intuitive and is viewed by most as a supply chain concept.

However, in two exceptional cases Clients were taking a high level economic view of productivity and exploiting opportunities to leverage long term user benefits through a focussed design/construct process.

Notwithstanding, a great deal of useful information was volunteered by participants. Over 80 separate drivers were noted, distilled and placed within the analysis framework. The key drivers are:

Client Leadership

- 'Intelligent' Clients with a background and understanding of the industry
- Client Leadership in clearly defining end user requirements and creating understanding.
- Client Single Point of Responsibility

Procurement

- Long-Term and repeat Relationships
- Bringing the Contractor on board early (ECI)
- Procuring contractors who take the time to thoroughly understand the end-users needs and who are afforded the opportunity to engage with them.

Defining The Project For Success

- Whole of Life (WOL) considerations and recognition of productivity as an economic concept as well as a cost concept.
- Benchmarking visits to similar 'Products'. Being prepared to look at other's work or processes and recycle great thinking.
- Clear timelines which are rationally set and understood by all stakeholders and with an open and collaborative approach to change.
- Tight budgets plus Open Book accounting

- Pre-planning. Putting much more emphasis on planning and much less on prematurely starting site-work to provide immediate evidence of progress.

Creating The Culture

- Adopting Collaborative Working Principles at every opportunity.
- Creating an environment of understanding through 'telling the story' as part of induction
- Comprehensive Stakeholder Management and Communications
- Creating a sense of 'Special' and consciously build an 'A' team environment.

Managing Performance

- Use of qualitative and quantitative KPIs as project management tools
- Use of Collaborative planning techniques
- Appropriately focussed value management
- Employment of construction engineering, services and BIM specialists by Contractors
- Modular Building, Off-site Manufacturing or Prefabrication

Closing The Project

- Comprehensive customer survey
- Performance measurement against internal and Industry standards- weighing the pig
- Post project review to capture learnings- fattening the pig
- Product based Cost Model/ Cost Libraries.

Most of the strong productivity drivers are 'soft' in an Industry with deep pride in its 'hard' skills and it will take committed and skilled leadership to bridge the cultural gap. In fact, Leadership may well be the sector's biggest skills challenge.

The report and the individual case studies which sit in behind it contain a wealth of information with which to validate proposals for further work. With this in mind the following conclusions and recommendations have been made:

Learning and Sharing: There is much to be learned from studying successful projects and talking with skilled practitioners.

1. ***Recommendation: Demonstration Programme:*** *Initiate a further ongoing programme of regular case studies similar to the BRANZ Pathfinder Programme.*

Culture: Coming through very strongly is the need for the culture of a project and a team to be strongly aligned towards leadership, teamwork, collaboration, integrated teams and celebration.

2. ***Recommendation: Focus on Culture:*** *Initiate a programme of research and action*

Performance Measurement: Section 8 shows that whilst the case study projects benchmark well against NZ and UK industries, there are clear areas for improvement around Quality, Cost and Client pre-planning.

3. ***Recommendation: Promote Industry Performance Measurement and develop Productivity Measures:***
4. ***Recommendation: Focus research and action on Quality and 'Defect-Free' outcomes***

Procurement: In Procurement, the importance of long-term relationships with integrated supply teams working collaboratively together to focus on the 'Product' is a loud message coming from all the projects.

5. ***Recommendation: Develop guidance on procurement*** *and promote the use of long–term relationships and integrated collaborative teams.*

Product Development: A reminder of the ultimate and potentially most potent productivity measure has emerged from this exercise. That is the opportunity for real economic benefit which is available by focussing the team on the productivity of the developed asset, or 'Product'

6. ***Recommendation:*** *Develop the 1:5:200 model* for specific products in New Zealand. Encourage clients to think about the long-term productivity benefits available through this approach.*

BIM/BEIM: It is clear from the findings of this study that many believe in the ability of BIM and BEIM to be a significant driver in the bid to improve the industries productivity.

7. ***Recommendation: Develop a research and action programme designed to assist the industry to successfully adopt BIM/BEIM.***

Lean Construction: There is much evidence from the projects examined in this study that the beginnings of Lean Construction principles of removing waste or Muda from the process are appearing across new Zealand.

8. ***Recommendation: Develop further research into Lean Construction principles and their impact on productivity.***

Modular Building: Where used appropriately, Modular building/Prefabrication has a 'game-breaking' impact on productivity.

9. ***Recommendation: Working with Pre-fab NZ, develop a research and action programme focussed on reviewing the opportunities and blockers of implementing Modular building/prefabrication on a large scale in NZ.***

Further recommendations include:

10. *That the Productivity Partnership socialises these findings through presentations and workshops*
11. *That the Productivity partnership open a forum for receiving feedback*
12. *That the framework of productivity drivers be used by the Productivity Partnership for future programme planning and delivery.*
13. *That the Productivity Partnership Initiate the development of* ***'Productivity Best Practice' guidance tools*** *aligned to the framework of productivity drivers possibly in collaboration with other representative sector and industry groups. Specific subject areas for inclusion could be:*
    a. *BIM/BEIM*
    b. *The development of Culture*
    c. *Procurement for long-term relationships*
    d. *'Product' Development in the industry*
    e. *KPIS and benchmarking*
    f. *Lean Construction*
14. *Follow up on the development of Productivity best practice guidance tools with the sponsorship of a complementary set of* ***training tools****.*

In addition to the recommendations for the Productivity Partnership above, there are a number of actions that the Industry can work on now. These are covered in section x

This project has been incredibly rewarding in that the volume of emerging data around the goal of improving productivity has proven to be vast, albeit covert. We look forward to the future with anticipation of many tangible outcomes conjoining to support the goal of the productivity Partnership to achieve a 20% increase in Productivity by the year 2020.

3 Introduction

3.1 Overview

This report was commissioned by The Productivity Partnership in March 2012 by The Evidence Workstream. It is the culmination of 4 months of work comprising some 30 in-depth interviews with various Construction Clients and members of the Supply Chain, all of whom have at least one thing in common; they have delivered at least one highly successful project in the past few years.

The role of this project has been to work to understand, through these projects and their participants, what, if any specific initiatives or drivers have impacted either negatively or positively on the outcomes of the project.

Despite the majority of the interviewees having little in the way of strong views on the subject of 'Productivity' per se, we have achieved this goal and have been able to document over 80 initiatives, two thirds of which are either drivers of positive impact on productivity, and the remaining third, drivers of negative impact. There will be more; however, this is a tremendous beginning from studying just 12 successful projects.

3.2 Purpose

The purpose of this research project has been to:

1. Explore the findings and outcomes from completed construction projects to identify common themes, processes and approaches that have delivered productivity improvements.
2. From these, identify the most common and universally applicable opportunities for driving productivity improvement and provide suggestions on where and how to intervene in the life-cycle of a project to most effectively influence productivity.
3. Recommend areas of potential future research which may not be covered by the scope of this project.

3.3 Goals

The goals of this research have been twofold:

1. To provide guidance, based on the research findings, for Project Sponsors, Clients, Professional Services providers and the Construction supply chain on strategies which appear most universally effective in lifting productivity.
2. To inform and provide guidance for follow-up research, mapping or workshop activities.

3.4 Scope

Nine projects have been selected from the BRANZ pathfinder case-study series for re-examination under the terms of this project. A further three projects not previously case-studied have been included also.

The scope of this research covers the impact on productivity of:

- the relationships between the industry stakeholders
- the construction process
- procurement and delivery processes
- Specific technologies and approaches such as whole of life value
- Specific practices to drive out inefficiency and waste (cost, time and process)

The BRANZ Pathfinder Projects were initially selected because elements of their design, procurement or execution were considered to represent

Industry best practice. They were considered within the sector to have been successful. Having been screened on this basis an opportunity has been created to examine perceptions around the relationship between successful and productive outcomes. Specific comment on this is incorporated in the report.

3.5 Methodology

Project Selection Projects were selected from the BRANZ Pathfinder Project lists to reflect:

- A mix of vertical and horizontal infrastructure projects
- A mix of green-field and extension/reconstruction projects
- Main centre and provincial locations.

The opportunity to select some additional projects from beyond the Pathfinder series provided the opportunity to include projects with a focus on a particular initiative:

- Supply chain integration
- Pre-fabrication
- An alliance generations model.

A full list of projects and interviewees is set out in section 5.

Interviews A series of interview questions built around the project brief were developed, (see appendix A).

A minimum of two and a maximum of four key individuals from each project team were interviewed for the nine main projects. The three additional projects comprised a single in-depth interview with the key individual who drove the initiative being examined.

A mix of Client, Professional Services and Contractor individuals were targeted for each project. The majority of interviews took between 1 and 1.5 hours to complete.

Quantitative Data The opportunity to benchmark behaviours and results to cross reference the qualitative findings with quantitative measures has been taken through application of:

The Construction Clients' 'Group 'Client Protocols' Survey applied on a 360 degree basis examining perceptions of Client behaviour from both Client representative and Supplier perspectives.

The National Construction Industry KPIs which enable international benchmarking. These measure performance of the project relating to:

- Client satisfaction with product and service,
- Predictability of time,
- Predictability of cost,
- Defects,
- Safety.

Analysis Raw interview responses were collated and reported in tabular form. Key themes have been collated and distilled around each project and then across the set of 12 into a brace of common productivity drivers (both positive and negative). These have formed the basis of follow-up discussion, comparison with the quantitative data, summary reporting and recommendation.

Report The main body of the report sets out the aggregated findings, set out around a model developed during the course of the analysis above.

The individual project findings, (some 8 to 12 pages each) are appended at Appendix C and are recommended as a rich source of further analysis.

4 The Projects

The following projects were chosen as BRANZ/CCG Pathfinder projects for further review. Between two and four individual Client and Supply Chain interviews were carried out for each project. KPI and CCG Protocol data collected where possible. Full case studies are available for each at Appendix C.

01 NZDF Training Facility

02 Auckland Zoo

03 Albany High School

04 Middlemore Hospital

05 BRANZ Redevelopment

06 Central Connector

07 Te Kura Kaupapa

08 Palmerston North Clock Tower

09 Wellington Sports Centre

The following three case studies were each new studies, (no previous Pathfinder case study available). The three were chosen as they offered the opportunity to look at a specific initiative and its impact on productivity. Each case study took the form of one in-depth interview with the individual responsible for the initiative. These were:

- Fulton Hogan Reseal /Paving Supply Chain Programme – Initiative, Supply chain integration
- NZTA 3 Generations of Alliance– Initiative, An alliance contract model.
- Stanley Group (University Hall) – Initiative, Pre-fabrication

Individuals and Organisations Participating in Interviews:

Hamish Boyd	Jasmax Associates	Consultant (Arch)	Albany Senior High School
Graham White	White Associates	Consultant (Client Rep)	Albany Senior High School
Julian Huggins	Arrow International	Contractor	Albany Senior High School
Michael Batty	Auckland Zoo	Client	Auckland Zoo
Logan Brewer	LBS Design	Consultant (Arch)	Auckland Zoo
Simon Barnes	Davis Langdon	Consultant (Cost Mgr)	Auckland Zoo
Brandon O'Reilly	NZ Strong	Contractor	Auckland Zoo
Hugh McKenzie	RLB	Consultant (Cost Mgr)	BRANZ Redevelopment
Tane Graham	FCC	Contractor	BRANZ Redevelopment
Jack Lyons	BRANZ	Client Rep.	BRANZ Redevelopment
Graham Long	Auckland Transport	Client	Central Connector
Tim Manning	Fulton Hogan	Contractor	Central Connector/ FH Reseal
Chye Choohian	Beca	Consultant (Eng)	Central Connector
Alex Smart	Counties Manukau DHB	Client	Middlemore Hospital
Euan MacKeller	Jasmax	Consultant (Arch)	Middlemore Hospital
Julian Huggins	Arrow International	Contractor	Middlemore Hospital
Jeff Vivian	Arrow International	Contractor	Middlemore Hospital
Jan Peterson	NZDF	Client	NZDF Training Facility
Phil Howard	Pacific Environments	Consultant (Arch)	NZDF Training Facility
Mark Bramley	MPM	Consultant (PM)	NZDF Training Facility
Gary Board	Ebert Construction	Contractor	NZDF Training Facility
David Smart		Consultant	Palmerston North City Clock Tower
Barry Robins	McMillan & Lockwood		Palmerston North City Clock Tower
Rob Cuff	PNCC	Client	Palmerston North City Clock Tower
Annie Day	Naylor Love	Contractor	Te Kura Kaupapa
Graham Wilson	Ministry of Education	Client	Te Kura Kaupapa
Graham White		Client Rep./QS	Te Kura Kaupapa
Jim Coard	Wellington City Council	Client	Wellington Sports Centre
Greg McFetridge	Mainzeal	Contractor	Wellington Sports Centre
	Beca	Alliance member	Alliance Generations
	Stanley Group	Specialist Contractor	University Hall

Figure 1 Interviewees

5 Success and Productivity

The BRANZ Pathfinder Projects, from which most of the research samples were chosen, were initially selected because elements of their design, procurement or execution were considered to represent Industry best practice. They were considered within the sector to have been 'successful'.

All interviews initially focussed on the success of the project. Without exception interviewees agreed that their projects were successful and were readily able to list and prioritise the primary success factors.

A number saw a specific initiative, relationship or process as having underpinned their project's success. However the defining characteristic of a successful project was Client or stakeholder satisfaction; often tied to the achievement of time, cost and quality objectives.

As the interviews changed focus from success to productivity, the ability to differentiate between the two concepts became difficult for many.

Most interviewees re-stated the success factors as the project's productivity drivers. For them a successful project outcome would almost certainly have been a productive one. However, their ability to demonstrate this was limited. Accordingly, the sector's perception of productivity remains largely intuitive.

With just a few exceptions, productivity was seen as either a programme or construction cost issue and in turn a labour issue. In this respect the sector is not assisted by the fact that sector statistics typically remain centred on labour productivity.

A high level view of productivity is "*The amount of efficient and effective infrastructure which can be created per unit of cost*"

While the construction supply chain does have some control over labour cost, it rarely has any control over the pre-construction functions which hold the largest potential for productivity gain at the higher level.

Ironically, the thinking of those who could have the greatest influence as policy makers, owners and designers was no broader than that of the construction supply chain.

A small number of Clients held the view that capital and operating cost were relatively small components in the productivity equation. They were generally institutional owner-occupiers whose thinking was firmly focussed on long term user outputs as the key productivity driver and who understood the philosophy contained within the 1:5:200 model (Figure 6.1).

For many this approach would seem somewhat idealistic when faced with limited capital resources and strained operating budgets. However, even the projects delivered by these Clients were little different in this respect.

What was different was their approach to value management. They focussed on the long-term user issues and established a corresponding set of non-negotiables. Where this limited the low hanging value management options it simply drove innovation further into the process.

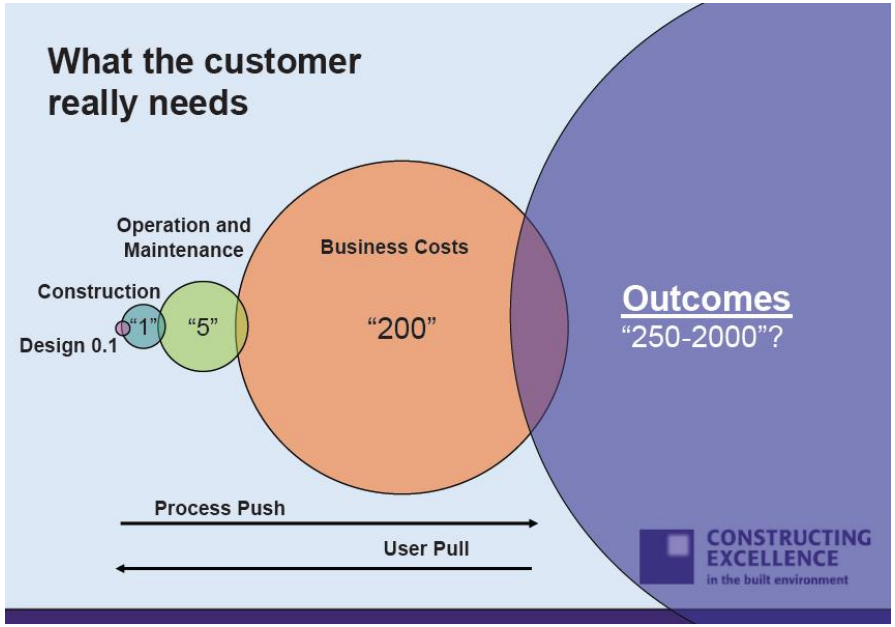


Figure 6.1 1: 5: 200 Model from the UK report 'Be Valuable'

The 1:5:200 model (Figure 6.1) is derived from a study comparing potential whole of life value of a facility against construction cost indexed at 1.0. The study suggests that for a $10m build cost:

- Operation and maintenance costs could total $50 million over the facility's lifetime
- Businesses operating from the facility could readily accrue costs of $2 billion over its lifetime
- The value of outcomes could conceivably range from $2.5 billion and be potentially limited by little more than imagination.

The accuracy of these figures could well be debated, but the point is that the economic value of our built environment is several orders of magnitude higher than its build cost and that the leverage available through looking to maximising the facility's productive capacity is potentially eye-watering.

As already noted, only two Clients, BRANZ and the Ministry of Education articulated the need to maximise their use of the supply chain to capitalise on the long term 'product' benefits.

Throughout this report, we have referred to this type of thinking as being **'Product Focused'** the concept of which is a key theme throughout the Egan report, 'Rethinking Construction' which has been so influential in the change of culture in the British Construction Industry over the past 12 years. The concept came from examining the way that the manufacturing industry (automotive for example) views the design, delivery and life-cycle of its products and supply chain.

The most prevalent measure of success amongst interviewees was that of meeting the expectations of Client or stakeholder. Often these expectations had little to do with productivity although it is acknowledged that a successful environment could well have been a productive one. Expectations were largely historic. Cost expectations were encapsulated by one interviewee as "Making sure we don't pay too much".

We know that expectations based on past performance will be generally self-fulfilling. For productivity to rise, so must specific expectations at Project level.

The 20/20 vision of the Productivity Partnership needs to be mirrored in project based productivity frameworks focused on increasing expectations.

The responsibility for building such frameworks needs to rest with the Project initiator and would include a very clear definition of what a high productivity outcome will mean to them. This framework would then be passed to downstream stakeholders and suppliers to the venture.

Such a framework might take the form of a charter which, as the project developed, encapsulated an integrated set of roles and objectives in managing productivity.

Some may be behavioural and potentially overlap with partnering philosophies. Some may be process or procedure driven while some will be technical.

All would be measurable and, most importantly, manageable.

Success and productivity are currently linked on an intuitive basis. The 20/20 objective of the Productivity Partnership will require a much more rational and consistent linkage between the two if it is to be met.

When they overlap, our work is done.

6 The Beginnings of a Framework

Analysis of interview results produced 80 potential productivity drivers. These were then categorised by:

- The nature of the driver's Impact on project outcome
- The number of projects on which the driver was identified as having had an impact.
- The stage of the project at which the driver had its initial impact.

The results of this work are set out in section 7 of this report.

The discussion in section 5 around the relationship between success and productivity suggested that there needed to be some kind of framework relating specifically to productivity which was carried through the project like a relay baton and which assumed 'top of mind' presence at critical milestones in the project cycle.

A natural progression from the categorisation and analysis of productivity drivers was further development of the framework concept which resulted in the representation set out in figure 6.1

Even in its current state of development it has potential to be used to:

- Display the potential drivers (positive and negative) of productivity in a logical project life-cycle sequence – acting as a pick list of potential initiatives available to a project Client and team (Ref. Section 7).
- Initiate further research into how each driver impacts productivity and how it is related to others.
- Catalyse and focus the development of guidance material for adopting and delivering each initiative.
- Educate individuals throughout the industry.
- Encourage the development of further initiatives through innovation.
- And more potential ideas yet to be discovered.

An observation is that there is so much data which has been extracted from the interviews that others may wish to carry out further analysis and indeed, one of the recommendations of this report is that this is just what should happen for probably each of the 80 drivers. To assist with this, a series of individual project case studies is set out at appendices X to x with the full information which was used to extract the 80 drivers.

One of the most interesting findings from the interviews is that, (with a few exceptions) most individuals do not spend much time thinking about productivity and if they do, it is not in quantitative or numerical terms. Rather, the main concerns are around measures of overall project success such as 'on-time' 'within budget', 'satisfied Clients' and 'end users' etc. Therefore, the role of extracting drivers of productivity from the interviews fell to the authors of this report.

6.1 The Framework

Each of the drivers set out in Section 7 has been collated into one of the 6 categories in the Framework to the right, (Figure 6.1). Some could arguably fall into more than one, however, each has been placed in preference to the context in which they occurred on the project(s) describing them.

In the order of key stages, it should be noted that **'Procurement, Getting the team on board'** comes directly after '**Client Leadership, the Groundwork'** and before **''Defining the Project for Success'.** This decision reflects the growing realisation of the importance to both the success and productivity of the project of engaging the whole team prior to defining the project and is discussed in further detail in Section 7.

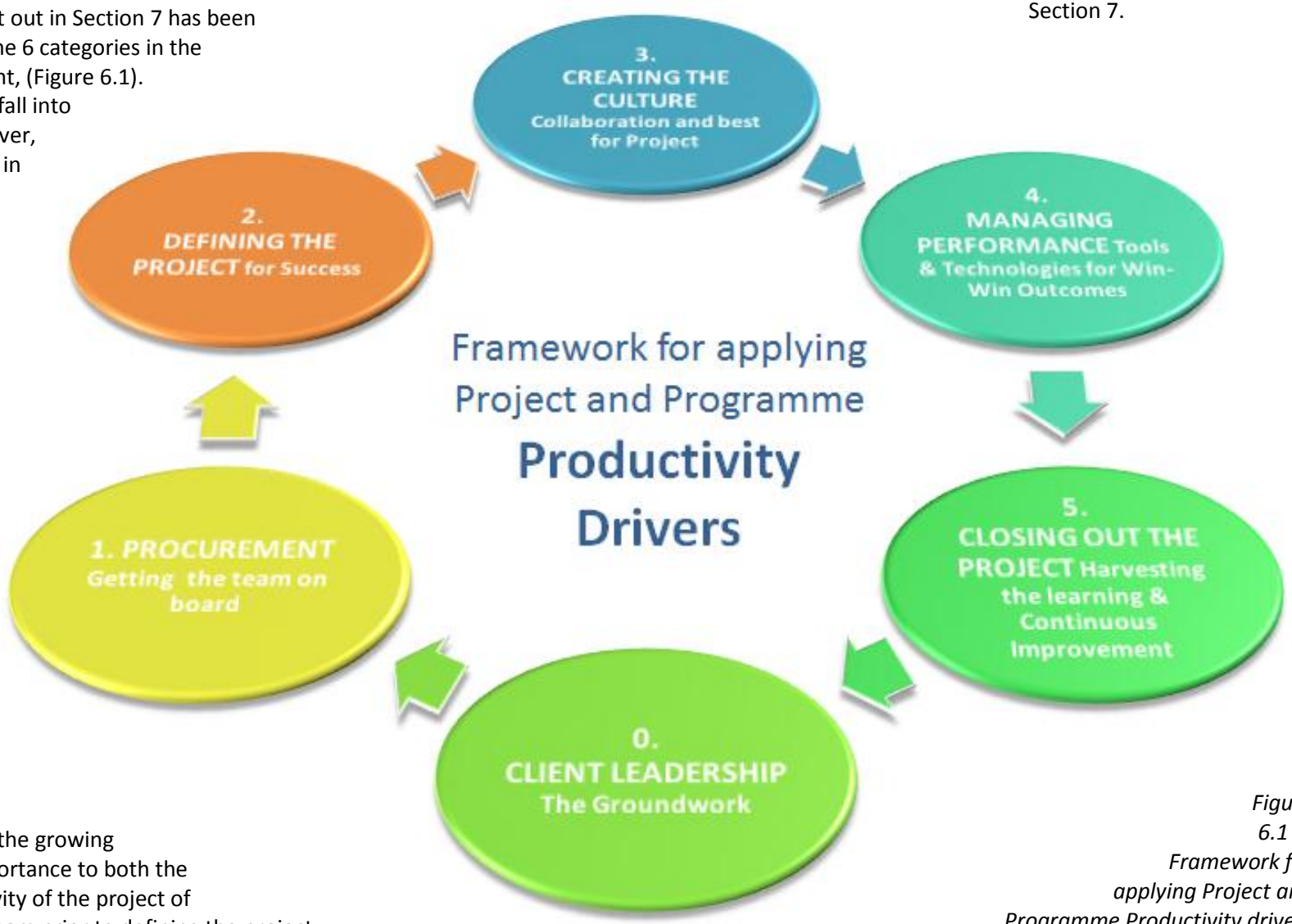


Figure 6.1 A Framework for applying Project and Programme Productivity drivers

6.2 Summary of 'Top 3' drivers of productivity

Section 7 lists all of the 80 drivers, this section sets out a summary of the top 3 to 5 positive drivers under each heading of the Framework. The top drivers have been chosen through a combination of those with the most strategic impact and those which occurred on the most projects. See section 7.0 for more detail on each driver along with project examples. [x.x] signifies the reference to each driver in section 7.0.

6.2.1 CLIENT LEADERSHIP The Groundwork.

This category covers activities and initiatives that correlate to the Clients' own thinking pre-project. It relates to the clients' strategy for developing their asset portfolio and the culture of the organisation as Construction Client. The top 3 drivers are:

- **Intelligent Clients with a background and understanding of the industry** and process can positively impact productivity where they work to assist the process. [0.1]
- **Client Leadership in establishing the project team to focus on the End User** leads to higher satisfaction of the 'Product' and higher productivity of the facility in use [0.2]
- **Client Single Point of Responsibility** leads to effective decision making which will reduce delays and lift productivity.[0.4]

6.2.2 PROCUREMENT Getting the team on board

This category refers to drivers around the procurement activities typically carried out project to project in New Zealand. As discussed in section 6.1, more and more evidence is being compiled that bringing the whole team on board prior to developing the project leads to higher performance outcomes. Figure 6.2l below summarises this change from 'Historic' thinking to 'Aspirational, (or modern) thinking around procurement of Built Environment Assets.

Figure 6.1 From Constructing Excellence UK 2001

The top 3 drivers are:

- **Long-Term Relationships** where a significant number of the team have worked together before means that the team's learning curve is reduced especially around each other's systems and processes. Clients can bring this about via procurement of 'Frameworks or Panels' (standard public sector approach in the UK) or the industry can bring this together by forming formal or informal consortia around specific 'Products' (facilities) such as zoos, schools, hospitals, etc. [1.1]

- **Bringing the Contractor on board early (ECI)** ECI does not have to be a formal procurement route, there are many ways to achieve this, long term relationships. There are numerous productivity advantages to having the contractors input to design not least cost, risk and programme advice as well as the all-important Buildability advice. [1.4]
- **Procuring contractors who take the time to thoroughly understand the end-users needs** and empowering them to take the time to engage them means reduced lost time towards the end of the project when users usually being to interact with the project and make costly changes. [1.5]

6.2.3 DEFINING THE PROJECT for Success

This category refers to drivers around Project definition. Many of the drivers require the full team of designers and constructors to be in place to define the project and its delivery process. The top 5 drivers for defining the 'Product' and the 'Process' are:

PRODUCT

- **Whole of Life (WOL) consideration** leading to impacts on productivity of the Product in use. [2.1]
- **Benchmarking visits to similar 'Products'**, (facilities) overseas and locally stimulates innovation and the sharing of best practice which lifts the productivity of the product in use as well as sharing buildability ideas to improve the productivity of the project in development. [5]

PROCESS

- **Clear deadlines** are a good driver for productivity especially from the contractor's point of view. It is not uncommon for a project not to set a specific DATE deadline or to have a vague idea of month to finish which leads to programme creep. [2.4]
- **Tight budgets plus Open Book accounting** coupled with long term relationships (supply team has worked together before) can bring higher productivity as the team works hard to deliver within the budget via alternative solutions to problems and opportunities. [2.5]
- **Pre-planning**. Projects usually are driven to start on site day 1 of letting the contract to the main contractor, however, delaying a start to give time to be spent on pre-planning with the whole team can pay dividends in improved productivity and improved delivery times. [2.6]

6.2.4 CREATING THE CULTURE

This category comprises the largest number of drivers found during the research. There appears to be a high level of correlation between projects deemed to be of a high' productive outcome and a real focus on establishing and maintaining a win-win, best for project, collaborative culture. The top 5 drivers for this this category are:

- **Comprehensive Stakeholder Management and Communications**, (for projects where there are a large number of internal and external stakeholders) reduces any negative impacts that *confusion* and misunderstandings amongst stakeholders can cause. [3.1]
- **Creating a sense of 'Special'** for the project that team increases the bond and attracts people to the project. It can create a sense of excitement around the project which has the effect that people enjoy being on the project. A sense of enjoyment often means that people go the extra mile which can lift productivity. [3.2]
- **'Telling the Story'** type induction meeting with Client. This start up meeting for all players especially Subcontractors (re-run every 2 months for new starters) sets the vision, creates a passion and enables all to see their role in what is an exciting project. [3.3]
- **Adopting Collaborative Working Principles** early on in the project works to enhance productivity as the team becomes integrated. These principles include: integrated planning, cost management, partnering, etc. [3.6]
- **Starting the project with a clear culture that this is the A team**, (and maintaining it) has the effect that people wish to do their best for the team and gives them confidence that they are able to do so. [3.4]

6.2.5 MANAGING PERFORMANCE Tools and technologies for Win-Win Outcomes

This category covers initiatives which are put into place for managing the project and can come from any member of the supply chain or the client. The emphasis is on collaborative tools that result in outcomes which benefit all players. The top 5 drivers are:

- **Contractor's in-house engineers/designers/BIM specialists** Some contractors are beginning to have their own in-house engineers and designers plus BIM specialists. This can have a very high impact on productivity on Buildability and cost reduction through alternative designs. There are issues with this however in the way the current market operates which are discussed further in section 7.0. [4.3]
- **Modular Building, Off-site Manufacturing or Prefabrication** can dramatically increase productivity as whole systems (walls, roofs, Bathrooms etc.) are developed in a controlled environment with lower skill levels, (using manufacturing processes) than those required on site and in a safer environment. On-site delivery timescales can be significantly reduced. [4.5]
- **Use of formal KPIs** as a set of lead indicators give clear indication of the progress of the project on a range of fronts. Whilst not necessarily focussing on productivity as such, they give a clear indication of the project's progress towards its own success driver. Some contractors use the National Construction Industry

KPIs for this, (4 projects) others have developed their own. Some share them with the client and ask for client input. Some use them for their own team only. [4.10]

- **Use of Collaborative planning techniques** enables real understanding of programme which leads to reduced misunderstanding and mistakes. The most common method used (found on 6 of the 9 Pathfinder projects) is 'Last Planner', a collaborative planning methodology developed initially in the US as a part of the Lean Construction tool set and introduced in 2006 by Constructing Excellence NZ. [4.7]
- **Value Management Techniques** can be used to help maintain the quality and functionality for a facility including maintaining a whole of life approach and sustainability features of a project within a budget rather than eliminating it from the project to cut costs [4.1]

6.2.6 CLOSING THE PROJECT Harvesting the learning and Continuous Improvement

This category covers the area of project management which is not done so well in most organisations. It holds the least drivers which emerged from the research. Typically, the team breaks up and moves onto the next project. The drivers found in this category represent some real innovation and genuine efforts by those involved to develop learning on both Product and Process. The top 3 drivers in this category are:

- **Post Project Reviews** carried out in-depth preserve the learning with an organisation and are even more powerful with long term relationship based supply teams. One outstanding example is the in=depth review on Middlemore Hospital carried out by Arrow. the findings of which are now taught in-house as productivity opportunities.
- **Product based Cost Model/ Cost Library**. Clients who deliver repeat products such as schools, hospitals, roads etc. are in a position to build up comprehensive cost models which enable them to set budgets, targets for cost reduction and benchmark projects. Examples include:
- **Customer Surveys** carried out mid-way and at the end of the project provide comprehensive feedback for continuous learning and improvement. Naylor Love and Arrow International carry out detailed customer surveys on all their projects above a certain value and some below.

7 Drivers of Productivity

Overall impressions from projects on issues that impacted Negatively or Positively on Productivity

Having introduced the Framework in Section 6, this section sets out the findings of the research in the context of this Framework.

Some 80 drivers of productivity (positive and negative) were found across the 12 successful projects analysed. The number of new drivers began to reduce as each successive project was analysed which gave confidence that the list of drivers was becoming comprehensive. No doubt, however, as new projects are analysed in the future, more will be discovered.

This section sets out in table form, each of the drivers in the context of the Framework described in Section 6 along with a range of additional criteria including:

- **Framework Context** Which stage in the lifecycle of the project would the driver have the most impact upon?
- **Positive or Negative** Is the driver one of Positive or Negative impact on the project, (a small number are neutral or yet to be defined either way)? Positive drivers are to be encouraged and negative drivers avoided where possible.
- **Impact Category** Which project outcome(s) or process(es) would the driver most impact upon? Outcomes or Processes have been categorised as: TIME, COST, QUALITY, PROCUREMENT, CULTURE, TECHNOLOGY, SKILLS, INNOVATION, PRODUCT. The term PRODUCT refers to the whole facility and its function.
- **No. Projects Impacted** How many projects did each driver apply to? A list of projects has also been supplied for further reference.

Key to Tables

Impact Category: Outcome(s) or Process(es) which the driver most impacts upon.

- TIME
- COST
- QUALITY
- PROCUREMENT
- CULTURE
- TECHNOLOGY
- SKILLS
- INNOVATION
- PRODUCT

Project Impacted:

01 NZDF Training Facility

02 Auckland Zoo

03 Albany High School

04 Middlemore Hospital

05 BRANZ Redevelopment

06 Central Connector

07 Te Kura Kaupapa

08 Palmerston North Clock Tower

09 Wellington Sports Centre

7.0 **CLIENT LEADERSHIP** The Groundwork

This category covers activities and initiatives that correlate to the Clients' own thinking pre-project. It relates to the clients' strategy for developing their asset portfolio and the culture of the organisation as Construction Client. The ten drivers found are:

7.0.1	Positive Drivers of Productivity	Impact Category	Projects Impacted	No. Imp.
0.1	**Intelligent Clients with a background and understanding of the industry** and process can positively impact productivity where they work to assist the process. (N.B. This can have a negative impact if their views are coloured by poor experiences, it can take time to build trust with a team. It can also have a negative impact if the procurement route is changed from collaborative to traditional part way through as in the case of Wellington Sports Centre.) Positive Examples include: **05 BRANZ:** "Bloody fantastic job" Never seen a Client get so involved. **08 CLOCK TOWER**: Council reps were energetic. They religiously led the weekly 'prayer meetings'. These were very useful and Client was "full partnership participant". They were open-minded.	CULTURE	01, 03, 05, 06, 08, 09	**6**
0.2	**Client Leadership in establishing the project team to focus on the End User Outcomes** leads to higher satisfaction of the 'Product' and higher productivity of the facility in use – (see the Constructing Excellence 1:5:200 model*)	QUALITY, INNOVATION	03, 04, 05, 06, 07	**5**
0.3	**Multi headed Clients partnering together**. Often, there are several asset owners involved in infrastructure (and some building) projects. Encouraging partnering between these organisations can improve the overall product and reduce maintenance costs going forward in addition to providing clearer leadership to the project team. " Also the need to respond to expedient political decision making."	CUTURE, INNOVATION, PRODUCT, TIME, COST, QUALITY	03, 06, 07, 08	**4**

0.4	**Client Single Point of Responsibility** leads to effective decision making which will reduce delays and lift productivity.	TIME, COST	01, 03, 04, 05, 06, 07, 08	**7**

7.0.2	**Negative Drivers of Productivity**	**Impact Category**	**Projects Impacted**	**No. Imp.**
0.1	**Client Changes often stem from an unclear brief** or as in this case a concept design which is so old many things needed to be updated. They always reduce productivity whatever the reason. Best Practice Clients work towards a design freeze point thereafter changes are made post-project which reduces the disruption to the project and overall minimises cost.	COST, TIME, QUALITY	01, 02	**2**
0.2	**Clients are often unclear about their needs at the outset of a project** This can lead to a long and resource intensive process using design resource which can result in design-stage delays and eat into time for construction where in-use deadlines are critical. Is this the best resource to use for brief setting or could VALUE MANAGEMENT* principles and professional resources be employed. This discipline is relatively rare in NZ but widely used overseas. Like Alliancing principles, often cited for large projects but both work equally effectively for long term relationships such as Frameworks* or panels*.	INNOVATION, PRODUCT, PROCUREMENT, TIME, COST, QUALITY, CULTURE	03	**1**
0.3	**Council Long Term Planning (LTP) processes are not always conducive to productivity** and long term thinking. If budgets are set several years earlier, attempting to stay within them can harm WOL potential of the project.	PRODUCT, INNOVATION, COST, QUALITY	08	**1**
0.4	**Multi-headed Clients create confusion and can delay decisions.** At best, they make the project hard work for the delivery team and at worst create a large negative impact on productivity, time cost and quality. The culture can be disrupted with a multi-headed leader as negativity slips in and individuals	TIME, COST, QUALITY, CULTURE	02	**1**

	are played off against each other in a bid to create a sense of achievement. **02 AUCKLAND ZOO:** In the zoo project, the MC and Lead architect worked hard to negate the symptoms of a multi headed Client and the Zoo provided a level of leadership.			
0.5	**Clients can engage end-user operational individuals too late in the process.** In this case, this adversely affected the AV system design and delivery.	PRODUCT, TIME, COST, QUALITY	04	**1**
0.6	**Unknown Underground Services can reduce productivity** through delays in both design and construction. For the future, Clients having a BEIM (Built Environment Information Model) with up-to-date asset information embedded, can negate these delays.	TECHNOLOGY, TIME, COST	02, 08	**2**
0.7	**Winter time ground works can reduce productivity** and increase cost. Causes of this can be due to poor Client pre-planning, design delays, funding or consent delays.	COST, TIME	01	**1**

7.1 1. PROCUREMENT Getting the Team on Board

This category covers activities and initiatives that correlate to activities around Procurement – assembling the team. A common theme relating to higher success and productivity across the projects is that of bringing the team together early in the project lifecycle, thus maximising planning opportunities and empowering the full scope of expertise available. For this reason, this theme has been set before the 'Project Definition' theme in the framework. The seventeen drivers found are:

7.1.1	Positive Drivers of Productivity	Impact Category	Projects Impacted	No. Imp.
1.1	**Long-Term Relationships** where a significant number of the team have worked together before means that the team's learning curve is reduced especially around each other's systems and processes. Clients can bring this about via procurement of 'Frameworks or Panels' (standard public sector approach in the UK) or the industry can bring this together by forming formal or informal consortia around specific 'Products' (facilities) such as zoos, schools, hospitals, etc.	INNOVATION, TIME, COST, QUALITY, TECHNOLOGY, CULTURE, SKILLS	01, 02, 03, 04, 06, 07, 08	7
1.2	**"Product" based experience of the design and construct team** can increase productivity. Each member of the team has deep experience in delivering school projects, e.g. Whites have completed 15 as Client rep. The Egan Report, Rethinking Construction* cites this factor as being one of the single most important factors to improve productivity, i.e. integrated teams come together to market and sell 'Products' such as schools, hospitals etc. with a focus on "Product Development and Innovation"	PROCUREMENT QUALITY, INNOVATION, COST, TIME	03, 06, 07	3
1.3	**Smart Contractors focus on being cheaper and faster through clever solutions** arrived at collaboratively with little or no compromise on quality and function. Often clients do not realise that low priced tenders can be the result of errors and omissions and procuring on such a basis leads to productivity losses that can often devastate the project's key drivers for the Client. Procurement needs to take into account the quality of the business being employed which means looking at the businesses evidence of excellence in the Baldridge Business Excellence sense.	PROCUREMENT, PRODUCT, TIME, COST, QUALITY, CULTURE, INNOVATION, SKILLS	01, 02, 03, 04, 05, 06, 07, 08, 09	9

1.4	**Bringing the Contractor on board early (ECI)** ECI does not have to be a formal procurement route, there are many ways to achieve this, long term relationship through Frameworks* being the best. There are numerous productivity advantages to having the contractor's input to design not least cost, risk and programme advice, as well as the all-important Buildability advice.	PROCURMENET, PRODUCT, INNOVATION, TIME, COST, QUALITY, CULTURE	03, 04, 05, 07, 08	5
1.5	**Procuring contractors who take the time to thoroughly understand the end-user's needs** and empowering them to take the time to engage them, means reduced lost-time towards the end of the project when users usually being to interact with the project and make costly changes.	PROCUREMENT, TIME, COST, QUALITY, CULTURE	02, 03, 04, 05, 06, 07, 08	7
1.6	**Procuring Contractors with good Buildability skills** along with bringing them in at the right time (see 'cost/value curve*') plus empowering them to make suggestions in integrated teams will enhance productivity.	PROCUREMENT, TIME, COST, QUALITY	02, 04, 08, 09	4
1.7	**Empowering the Main Contractor to procure 'Preferred Suppliers'** cannot be understated as to the impact on Productivity. Often the main contractor is forced to procure sub-standard subcontractors in order to win the project on price or to provide 'lowest price'. They will often be aware of the sub-contractors' shortcomings and try to manage them out through their own staff. This often fails and sub-standard work impacts time, cost and quality of the overall product. Examples include: 03 ALBANY HIGH SCHOOL: In this case study, Albany High School, the MC was allowed to close-tender amongst their preferred suppliers whom they have vetted and know will be able to deliver a quality service within the time and budget. 05 BRANZ REDEVELOPMENT: This was an important 'risk mitigation' measure on the BRANZ project.	PROCUREMENT, TIME, COST, QUALITY	03, 04, 05	3
1.8	**Setting Criteria in Quality attributes during Procurement** to score highly Designers and Contractors who have worked together before, gives a head-start on productivity (see Long Term Relationships).	PROCUREMENT, TIME, COST, QUALITY	03, 04, 05, 07	4

1.9	**Negotiation on second + stages** of work or new projects keeps a working team together which brings productivity gains through learning curves on the Client, processes, communications etc.	TIME, COST, QUALITY	01, 03, 04,	3

7.1.2	**Negative Drivers of Productivity**	**Impact Category**	**Projects Impacted**	**No. Imp.**
1.1	**The Consent Process moves Clients to full design with a very high level of detail before they can bring on their contractor.** Once the contractor is on board they often see ways of achieving the design using alternative methods which reduces the productivity of the project overall. This is either too late or requires costly redesign. Early Contractor Involvement operated well, along with developing Frameworks for long term relationships means that the Client can call on the Buildability advice of the contractor at an early stage removing the negative impact on productivity.	PROCUREMENT, TIME, COST	02	1
1.2	**Bringing Contractors on board too late can reduce Productivity** by necessitating re-design either through Buildability issues or Budget issues	PROCUREMENT, TIME, COST	03	1
1.3	**Insufficient planning time for the contractor**. Procurement processes are often too late in the process which condenses the construction time and adds pressure to start on site within a short time from letting the contract (often 2 weeks). This does not allow the team enough time to plan the project sufficiently and can lead to productivity issues downstream. See Bringing the Contractor in early – ECI techniques and Long Term Relationships.	PROCUREMENT, TIME, COST	03	1
1.4	**'Hard Bidding Subcontractors'** Main Contractors who are selected on attributes or on a negotiated basis sometimes choose or are told to 'hard bid' subcontractors which can mean appointing an unsuitable subcontractor based on errors in price or lower quality of service, hence impacting on productivity during the project.	PROCUREMENT, TIME, COST, QUALITY	05, 06, 09	3

1.5	**Subcontractors who go into receivership** part-way through a contract can have serious impacts on productivity. It is not general practice in NZ to carry out due diligence on Main Contractors or Subcontractors therefore the risk of this occurrence can be high in certain markets.	TIME, COST PROCUREMENT	01	1
1.6	**Large number of Sub-consultants** can add complexity and reduce productivity through additional communications requirements.		01	1
1.7	**Changing Procurement routes part way through** from collaborative to traditional can be highly disruptive for morale, team-building and trust.	CULTURE, TIME, COST, QUALITY	09	1

7.1.3	**Neutral Drivers of Productivity**	**Impact Category**	**Projects Impacted**	**No. Imp.**
1.1	**Contracts seem to neither help nor hinder project's productivity.** With the exception of contracts that are well-known which enable the team to largely ignore them in confidence that they understand them. Most individuals commented that the contract was never reviewed during the project once it was signed.	PROCUREMENT, CULTURE	01, 02, 03, 04, 06, 07, 08, 09	8

7.2 **2 DEFINING THE PROJECT** for Success

This category covers activities and initiatives around defining the project. A key theme emerging is that of defining the project around Whole of Life. Green Star is having an impact on the building side. In contrast, there is surprisingly little 'Product' benchmarking as consultants in particular seem to view each project as being unique. A further simple theme that emerged was the fact that simply setting a tight deadline encourages innovation around ways to be more productive. The twelve drivers found are:

	7.2.1 Positive Drivers of Productivity	Impact Category	Projects Impacted	No. Imp.
2.1	**Whole of Life (WOL) consideration** leading to impacts on productivity of the Product in use, (1:5:200 model*). Examples include: **04 MIDDLEMORE HOSPITAL:** Rare Whole of Life (WOL) consideration on this project in that the life time of the building has been taken into account in the design such that it is 'demountable' and could take a change of use from a teaching block to an administration block. The Natural Step (TNS)* encourage this approach generally as a positive step towards the Built Environment becoming more sustainable as a whole. **06 CENTRAL CONNECTOR**: Focused on a 5 year moratorium on no more work in the area such that the product has to function for that period of time without intervention, other than normal maintenance. **07 TE KURA KAUPAPA:** The project was a mandatory 5* Green Star product which drove initiatives for the facility to be more productive in use – natural light, ventilation etc. **08 CLOCK TOWER**: The original Clock Tower had developed concrete cancer and so there was considerable thought and effort put into the new one to ensure that it could endure time well.	PRODUCT, INNOVATION	04, 05, 06, 07, 08, 09	6

2.2	**Benchmarking visits to similar 'Products'**, (facilities) overseas and locally stimulates innovation and the sharing of best practice which lifts the productivity of the product in use as well as sharing buildability ideas to improve the productivity of the project in development	QUALITY	03, 04, 05, 06, 07	5
2.3	**Compressed Construction Periods** can have the impact of maximising productivity through innovation such as Off-site Manufacture and Prefabrication, Standardisation, Materials selection, Design for Manufacture, (A Lean Construction principle). They also emphasise more thorough pre-planning and on-going planning. **06 CENTRAL CONNECTOR:** In this project, the scope was increased by 40% but the team accommodated it within the original timescale and delivered earlier through planning.	INNOVATION, TIME	03, 04, 06	3
2.4	**Clear deadlines** are a good driver for productivity especially from the contractor's point of view. It is not uncommon for a project not to set a specific DATE deadline or to have a vague idea of month to finish which leads to programme creep. NB Contractors always aim to finish early on lump sum projects as they gain margin on saved P&G.	TIME	01, 02, 03, 04, 06, 08	6
2.5	**Tight budgets plus Open Book accounting** coupled with long term relationships (supply team has worked together before) can bring higher productivity as the team works hard to deliver within the budget via alternative solutions to problems and opportunities.	COST	01, 02, 03, 04, 08	5
2.6	**Pre-planning**. Projects usually are driven to start on site day 1 of letting the contract to the main contractor, however, delaying a start to give time to be spent on pre-planning with the whole team can pay dividends in improved productivity and improved delivery times. Examples include: **06 CENTRAL CONNECTOR:** The team delayed a start by 3 months to really understand the plan with all the stakeholders. The result was 40% increased scope being delivered early on the original timescale.	TIME, INNOVATION	06, 08	2

2.7	**Realistic approach to Risk and Risk Budget Setting** at the outset helps the team make decisions quickly and enhances the culture of staying in control. If the risk is pre-planned and budgeted for it can easily be accommodated and the team do not feel a negative impact of 'sense failure that something has gone wrong', instead a sense of 'We are still the A-Team as we thought of this and handled it' is maintained which goes to the effect of maintaining productivity.	COST, TIME, CULTURE	02, 05, 08, 09	4
2.8	**Operational facilities which need to be maintained during construction can have a positive impact on productivity** through the need for better planning	CUTURE, SKILLS, TIME	01, 02, 04, 05, 06	5

7.2.2	**Negative Drivers of Productivity**	**Impact Category**	**Projects Impacted**	**No. Imp.**
2.1	**Lack of 'Product' Benchmarking** reviews and visits result from a common view that the project is 'unique'. Productivity gain opportunities are potentially lost from both the delivery process (design and construction) and the product in use.	PRODUCT, INNOVATION, CULTURE	05, 06	2
2.2	**Whole of Life (WOL) considerations are often sacrificed** to capital cost budget considerations and issues such as speed of build. This can have the effect of reducing the productivity of the facility in use	PRODUCT, QUALITY	03	1
2.3	**Innovation can impact negatively on a project's productivity** through learning curves and trial and error. Best practice integrated teams work together on innovation off-line from projects through long-term relationships similar to 'product and process development' in the manufacturing industry.	INNOVATION, PRODUCT, CUTURE, SKILLS	01, 05, 09	3
2.4	**Sustainability can negatively impact productivity** due to the amount of new information (learning curve) which needs to be taken on board. The balance is between productivity and innovation. A consideration for any new innovation which includes changing to a more modern form of contract for example.	INNOVATION SUSTAINABILITY	01	1

7.3 **3 CREATING THE CULTURE** Collaboration and best for project.

This category covers the theme of creating a culture of collaboration which was a common recurrence across all the projects examined. The 16 drivers are:

7.3.1	Positive Drivers of Productivity	Impact Category	Projects Impacted	No. Imp.
3.1	**Comprehensive Stakeholder Management and Communications**, (for projects where there are a large number of internal and external stakeholders) reduce any negative impacts that confusion and misunderstandings amongst stakeholders can cause.	CULTURE, TIME, COST, QUALITY	01, 02, 03, 04, 05, 06, 07, 08, 09	9
3.2	**Creating a sense of 'Special'** for the project team that increases the bond and attracts people to the project. It can create a sense of excitement around the project which has the effect that people enjoy being on the project. A sense of enjoyment often means that people go the extra mile which can lift productivity. Examples include: **01 NZDF:** A number of factors worked to achieve this on the NZDF project. These were a) the remoteness of the site causing car-pooling which created a bond. b) Guns going off around the site meetings creating a sense of excitement through difference. c) The sense of A team created through the single site meetings. **02 AUCKLAND ZOO:** A number of factors worked to achieve this on the Zoo project. These were: a) The 'Telling the Story' inductions every 3 months or so. b) Meeting the animals – the ultimate end users with their own special needs. c) Fun based competition through concurrent stages owned by teams. d) Impromptu events such as Ice Cream days, BBQs, family days etc. e) Encouraging individuals to show their families their particular contribution on the project.	CULTURE	01, 02, 04, 05, 06, 07, 08	7

	04 MIDDLEMORE HOSPITAL: A number of factors worked to achieve this on the Middlemore Hospital project. These were: a) The innovation required around being a demountable, reusable facility. b) Using modular building techniques and benchmarking performance around them. c) The sense of A team created through the long term relationship of Arrow, Whites and Jasmax, all companies with a culture of Excellence. **05 BRANZ:** Focused on team building through activities and events such as 'BRANZ Challenges' - Several sports events between BRANZ staff and project team. Regular site tours. "Fish and Chip" sessions when targets reached. **06 CENTRAL CONNECTOR:** Partnering Charter, Co-Location, various celebrations of completing milestones on time including awards, Family days and Single project branding. **07 TE KURA KAUPAPA:** The team were immersed in the Maori culture and special celebrations included the families of the people involved in the project. **08 CLOCK TOWER:** The fact that the Client chose to run ECI was seen as a privilege by contractor which they felt they needed to honour by delivering an exceptional result.			
3.3	**'Telling the Story'** type induction meeting with Client This start up meeting for all players especially Subcontractors (re-run every 2 months for new starters) sets the vision, creates a passion and enables all to see their role in what is an exciting project. It focusses everyone on the whole project (or Product in 'Egan'* language) rather than the usual focus on their disaggregated part. Creates a sense of 'privilege to be involved' and pride. Understanding the whole project can aid more rapid decision making at all levels which enhances productivity. 02 AUCKLAND ZOO: On this project, the induction enabled new players to understand the special needs of this project – the importance of not using materials that could be toxic the animals, working in an operational zoo etc. **06 CENTRAL CONNECTOR:** The partnership approach meant that the Vision was continually told and re-told along the journey.	CULTURE, TIME, COST, QUALITY	02, 06, 07	3

	07 TE KURA KAUPAPA: On this project, the team constantly reviewed the vision and were immersed in the Maori culture.			
3.4	**Starting the project with a clear culture that this is the A team**, (and maintaining it) has the effect that people wish to do their best for the team and gives them confidence that they are able to do so.	CULTURE	01, 02, 03, 04, 06, 07, 08	7
3.5	**Good Individuals** on a project are a vital ingredient to a productive project. Even within a company individuals vary. Examples include: **01 NZDF:** Another project which used the same companies as the NZDF project but which was not so successful due to lower quality individuals. **02 AUCKLAND ZOO:** Brandon O'Reilly introduced a series of ideas establishing the culture, which drove a successful project in spite of multi-headed Client and unusual design documentation (mostly sketches and artists' impressions). **04 MIDDLEMORE HOSPITAL:** The CM role (in this case Craig Brosnan and Jeff Vivian) is critical to setting the culture and providing leadership. **05 CENTRAL CONNECTOR:** On a hard bid, traditionally procured project, the leadership skills of the Main Contractors' Tim Manning brought a partnering philosophy to the project which resulted in a co-located, best for project, single branded team which delivered 40% increased scope in ahead of the original deadline for the project. **07 TE KURA KAUPAPA**: The team all worked well together almost as a 'self-managed team' - "At every stage the project felt successful. There was no particular leader in development of culture, "lowish" ego people for whom collaboration was natural. All keen to "stop, look and listen." **09 WELL SPORTS CENTRE:** The Client discussed the project relying on a number of "very good individuals."	SKILLS	01, 02, 03, 04, 05, 06, 07, 09	8
3.6	**Adopting Collaborative Working Principles** early on in the project works to enhance productivity as the team becomes integrated. These principles include: integrated planning, cost management,	TIME, COST, QUALITY, CULTURE	03, 04, 05, 06, 07, 08	6

	partnering, etc.			
3.7	**Single project identity** builds a 'best for project' type culture and can be encouraged on any type of project. Examples include: **06 CENTRAL CONNECTOR:** On this traditionally procured project, the Contractor's CM pushed for a partnering approach along with a single project brand. The team delivered 40% increased scope in early on the original deadline.	CULTURE	06	1
3.8	**Integrated Team Meetings** create a 'one-team' culture, reduce travel time and increase productivity as decisions are made and solutions developed in the meetings. It is usual to have a separate contractor site meeting with the design team and then a further separate 'PCG' (Project Control Group) meeting with the Client and the consultants. This adds cost and time to the consultants and disaggregates the team. A single meeting reduces these factors and enhances team culture.	CUTURE, TIME, COST	01, 02, 03, 04, 05, 06, 07, 08	8
3.9	**Co-Location**. Where possible improves communication and morale, both inputs into a team's overall productivity.	CULTURE, INNOVATION, PRODUCT	06	1
3.10	**Introducing a Partnering Charter** and overall Partnering approach even on traditionally procured projects can bring numerous positive impacts on productivity. The approach can be used to bring in initiatives which serve focus on 'best for project' outcomes such as co-location, single project branding etc. normally reserved for large projects operating under an Alliance.	CULTURE, INNOVATION, PRODUCT	06, 08	2
3.11	**Keeping People Happy** is cited to lift productivity. This needs to happen both at project level and company level in the supply chain. It is normal in advanced countries e.g. UK for best practice Clients to ask questions during procurement about staff development and satisfaction. This is not so usual in NZ.	CULTURE	01, 05	2

3.12	**Swapping out individuals who don't fit**. The ability of the Client and project leaders to identify and deal with individuals who, (for whatever reason are creating a negative impact on the team) quickly and swap them out if necessary, reduces any negative impact these team members have on productivity. This is a sensitive issue and is not always tackled up front on projects or head on.	CUTURE, TIME, COST	02, 04, 06	3
3.13	**Focus on Quality from Day 1.** On this project, it was cited that 'the builders were more concerned with quality than the Client'. This often stems from pride in the job which stems partly from skills and partly from understanding their own role in the project and how it contributes to the whole 'Story'. Productivity is enhanced through reduced re-work and 'getting it right first time'.	QUALITY, CULTURE	02, 05	2
3.14	**Right First Time** focus reduces defects, too many of which can seriously reduce productivity.	TIME, COST, QUALITY	06	1
3.15	**Concurrent Stages**. Where appropriate, splitting the project into concurrent stages and allocating teams to each can generate a fun sense of competition whilst enabling site access to be rationalised and reduces the need to travel over finished works. This can enhance productivity through internal competition to be the fastest, cheapest and most productive etc.	TIME, COST, QUALITY, CULTURE	02	1

7.3.2	**Negative Drivers of Productivity**	**Impact Category**	**Projects Impacted**	**No. Imp.**
3.1	**Architects are not generally concerned with Productivity.** This can impact the project causing design delays or other impacts caused by a lack of focus on productivity where architects take a lead role on the project formally or informally or have a strong influence on the project through character, for example. In this case, Jasmax are concerned with it to an extent and have tried some methods of measurement but with self-admittedly low levels of success.	TIME, COST CULTURE	01, 02, 03, 04	4

7.4 **MANAGING PERFORMANCE** Tools and Technologies for Win-Win Outcomes

This category covers initiatives relating to common and emerging tools and technology. In the main, most are are used collaboratively for best effect. BIM is a recurring theme, however, it seems to be only used superficially for the visuals rather than its full functionality although all recognise its potential. The sixteen drivers found are:

7.4.1	Positive Drivers of Productivity	Impact Category	Projects Impacted	No. Imp.
4.1	**Value Management Techniques** can be used to help maintain the quality and functionality for a facility including maintaining a whole of life approach and sustainability features of a project within a budget rather than eliminating it from the project to cut costs.	PRODUCT, COST, INNOVATION	09	1
4.2	**Regular Value Engineering Workshops** enable an integrated team to thoroughly understand a project prior to building it. In this case, the project held a 'Buildability meeting' each week to work out details and it was attended by the QS who was reluctant at first but saw the benefit of reduced time in managing costs as they went on.	TIME, COST, QUALITY	02, 08, 09	3
4.3	**Contractor's in-house engineers/designers/BIM specialists.** Some contractors are beginning to have their own in-house engineers and designers plus BIM specialists. This can have a very high impact on productivity on Buildability and cost reduction through alternative designs. There are issues with this however, in the way the current market operates. These include: a) These contractors will have a higher overhead and could be priced out at tender stage, even though it is more likely they will deliver inside the budget with these skills on board. b) The consent process can be unwieldy when it comes to the contractor as they are often on-board after consent has been granted which leads to costly redesign to gain the cost and time benefits	TIME, COST, QUALITY	02, 03, 04	3

	suggested by the contractor. c) Liability issues have to be thought through.			
4.4	**Contractor's use of BIM Examples include:** **02 AUCKLAND ZOO:** In this case, the use was for complex design (steel on an Aviary) which could not be understood without it. The contractor reduces their margin by employing these skills, but often gains back and some on the enhanced productivity. Note: Productivity could be even further enhanced if designers were encouraged to design in BIM from the outset negating the need for contractors to remodel. **03 ALBANY HIGH SCHOOL:** The use was early modelling to attain buy-in of Client side stakeholders. The contractor acknowledges that more use of full BIM would be helpful towards productivity in the future but there are issues of who invests. **04 MIDDLEMORE HOSPITAL:** The use was for high-level design. The contractor recognises that more use of BIM in future projects would be highly beneficial.	TIME, COST, QUALITY	02, 03, 04	3
4.5	**Modular Building, Off-site Manufacturing or Prefabrication** can dramatically increase productivity as whole systems (walls, roofs, bathrooms etc.) are developed in a controlled environment with lower skill levels, (using manufacturing processes) than those required on site, and in a safer environment. On-site delivery timescales can be significantly reduced.	PROCUREMENT, TIME, QUALITY, INNOVATION	03, 04	2
4.6	**Using Lean Construction Principles** – Ohno's 7 Principles of Waste*. These principles, adapted from the Toyota Production System, look at reducing 'Muda' or waste throughout the project on all activities. The principles are practiced extensively in Japanese sites and were observed first-hand by a CCG study tour in 2010. Examples included: **02 AUCKLAND ZOO:** The team were encouraged by the CM (pre-trained) to spend time at the end of each day planning so that cheaper labour could stock-pile materials and equipment for them ready for the next day which saved an hour or so at the beginning of each day.	TIME, COST, CULTURE	02, 06	2

	02 AUCKLAND ZOO: Each team had a trolley made up for their material and equipment with their name on it which encouraged tidiness and ownership – using principles form Arnold Mol.*			
4.7	• **Use of Collaborative planning techniques** enables real understanding of the programme which leads to reduced misunderstanding and mistakes. Techniques used on this project and others are 'Last Planner'*, (02, 03, 04, 05, 06, 07), a collaborative planning methodology developed initially in the US as a part of the Lean Construction tool set and introduced in 2006 by Constructing Excellence NZ. The other method is 'On the Arrow' or 'Bubble' planning from Warren Hollings (03, 04).	**TIME, COST, CULTURE, SKILLS**	02, 03, 04, 05, 06, 07	6
4.8	**Good Design Management** enhances productivity in both the design and the construction stages. Often, design fees do not encourage consultants to manage design well as all fees are spent on the actual design process. Also, some consultants are just not as skilled in this area as they are in design itself. Having a separate design manager can lift the productivity of the design team leading to better contractor productivity.	TIME, COST, QUALITY, CULTURE	01	1
4.9	**THE WORM** – MPM have developed a tool in-house to monitor contractors' productivity using percentages. *"We take the programme and analyse the contractor's programme and monitor every activity of man-days – e.g. 90 man-days work if 10% complete will work out ten days done and 80 days to go. Would spit out definitive – 70 man-days work should have achieved 100 not 90 so ten days behind – used a lot and the contractors react wide-eyed and are often surprised and asked for copies of MPM system."*	TECHNOLOGY, TIME	01	1
4.10	**Use of formal KPIs** as a set of lead indicators to give a clear indication of the progress of the project on a range of fronts. Whilst not necessarily focussing on productivity as such, they give a clear indication of the project's progress towards its own success driver. Some contractors use the National Construction Industry KPIs for this, (03, 04, 07, 08) others have developed their own, (05, 06). Some share them with the Client and ask for Client input. Some use them for their own team only.	INNOVATION, CULTURE, SKILLS	03, 04, 05, 06, 07, 08	6

7.4.2	Negative Drivers of Productivity	Impact Category	Projects Impacted	No. Imp.
4.1	BIM is often used superficially as fly-throughs at the beginning of the project which reduces the opportunities for productivity gains by employing the full uses of BIM.	TIME, COST, QUALITY	05, 07	2
4.2	**Small design consultant practices** (possibly a large proportion of NZ's design practices) **cannot or will not invest in BIM** and other technologies. Often they can be afraid of the technology as they do not understand it and therefore limit its adoption and prevent potential leaps in productivity gains.	TECHNOLOGY (BIM) TIME, COST, QUALITY	01, 07, 08	3
4.3	**QS's can be nervous if using full BIM** with cost models included as they can feel that their role is threatened. With familiarity this fear can be ameliorated.	CULTURE	04	1
4.4	**BIM can suffer if the designers use different modelling platforms.** Productivity gains can be compromised by supply team members such as Steel Subcontractors having to merge models and effectively build their own.	INNOVATION, PRODUCT, QUALITY, COST, TIME	09	1
4.5	**RFIs reduce productivity** due to delays and waiting time.	TIME, COST, QUALITY	01	1
7.4.3	**Neutral Drivers of Productivity**	Impact Category	Projects Impacted	No. Imp.
4.1	**On-Site Waste Minimisation Regimes** may or may not impact productivity. This should be investigated as the number of projects adopting this initiative grows as land-fill issues come on line. Research required.	INNOVATION, TIME, COST	05, 07	2

7.5 **CLOSING OUT THE PROJECT** Harvesting the Learning and Continuous Improvement

This category covers activities and initiatives relating to closing out the project. It is the smallest collection of drivers as it is arguably the stage of the project with the weakest performance as demonstrated by the benchmarking results in section 8.1. This is possibly symptomatic of the project by project nature of the industry treating each one as unique rather than and programme of continuous learning. The nine drivers found are:

7.5.1	Positive Drivers of Productivity	Impact Category	Projects Impacted	No. Imp.
5.1	**Post Project Reviews** carried out in-depth preserve the learning with an organisation and are even more powerful with long-term-relationship-based supply teams. **04 MIDDLEMORE HOSPITAL** Arrow carried out an in-depth full project review, the findings of which are now taught in-house as productivity opportunities. **07 TE KURA KAUPAPA** Naylor Love carry out in-depth customer surveys and measure their projects using the National Construction Industry KPIs. The surveys are used as a learning tool for future projects.	CULTURE, INNOVATION, PRODUCT	04, 07	2
5.2	**Product based Cost Model/ Cost Library.** Clients who deliver repeat products such as schools, hospitals, roads etc. are in a position to build up comprehensive cost models which enable them to set budgets, targets for cost reduction and benchmark projects. Examples include: The Ministry of Education holds a cost library comprising data from over 100 school projects.	COST	07, 09	2
5.3	**Customer Surveys** carried out mid-way and at the end of the project provide comprehensive feedback for continuous learning and improvement Examples include: Naylor Love and Arrow International carry out detailed customer surveys on all their projects above a certain value and some below.	CULTURE, PRODUCT, INNOVATION, SKILL	03, 04, 07, 08	4

5.4.1	**New possible KPI**: Product in Use, (See UK DQI system*)	PRODUCT	03, 04, 05, 07, 09	5
5.4.2	**New possible KPI**: No. of RFIs, (or similar measure around volume and impact of RFIs) measured from the contractor's point of view gives the contractor an idea of forward productivity as RFIs reduce productivity due to delays and waiting time.	TIME, COST, QUALITY	01, 05	2
5.4.3	**Possible new National KPI set** – Sqm per day. Some of these details exist in Rawlinsons – how could they be simplified to include some high level KPIs, e.g. Fit-out etc?	INNOVATION, TIME, COST, QUALITY	03, 04	2
5.4.4	**Possible Future KPI** - $per month or week, $per manday/week. This project was similar in $ to another project which had a much longer build period.	COST, TIME	03	1

7.5.2	**Negative Drivers of Productivity**	**Impact Category**	**Projects Impacted**	**No. Imp.**
5.1	**Most Clients and supply teams do not formally measure or benchmark**. Some are using the National Construction Industry KPIs* and proving good results, but generally when asked about KPIs, most answer just the usual programme and cost.	TIME, COST, QUALITY, CULTURE	01, 02, 05, 09	4
5.2	**Changing out the Contractor's Contract Manager (CM) or Site Manager (SM) just before hand-over** is quite common for projects that run over schedule as often they have holiday booked at the 'planned' end of the project. This can often reduce the productivity of an otherwise excellent project right at the end as these appointments are critical not only for Client confidence but also for morale of the team including subcontractors towards the finish line. Completing snags (defects identified pre-handover) becomes much more of a chore as relationships have been changed. Examples include: **07 TE KURA KAUPAPA** On an otherwise excellent project, the NL project manager's time on the site was significantly reduced and the service during this period reduced as a result.	QUALITY, TIME, CULTURE, SKILLS	07	1

8 Quantitative Data

8.1 National Construction Industry KPIs

The NZ Construction Industry KPIs have been used for benchmarking in New Zealand since 2004 and were established by an industry wide Steering Group comprising clients, supply chain and representative industry bodies. The KPIs (detailed in the table to the right) have been adopted by several organisations including clients and suppliers.

The NZ KPIs link directly to KPIs operated by UK Clients and the wider industry supply chain organisations. This approach has enabled direct benchmarking with UK project performance including the best practice projects, 'UK Demonstration Projects'.

The key benefits of measuring project performance via National KPIs are that for those organisations adopting them as part of a continuous improvement programme, a larger percentage of their projects achieve improved time, cost, quality, H&S, sustainability and customer satisfaction results.

For this project, each of the projects was asked for specific quantitative information which could then be analysed into an overall benchmark report for the project group. This section comprises an benchmarked overview across the 8 projects which were able to provide data and an individual 'spidergraph' for each project.

*It is important to note that the benchmark information is dated 2006, the last time a full national data set was collected. The UK set is up to date.

Looking forward, the Construction Clients' Group (CCG) is in the process of collating and up to date set for 2011 data for its members. This will be available for benchmarking by the end of 2012. It will not represent the full industry, just CCG members, both clients and supply chain.

8.1.1 Overview of 8 projects benchmarked against NZ 2006 data*

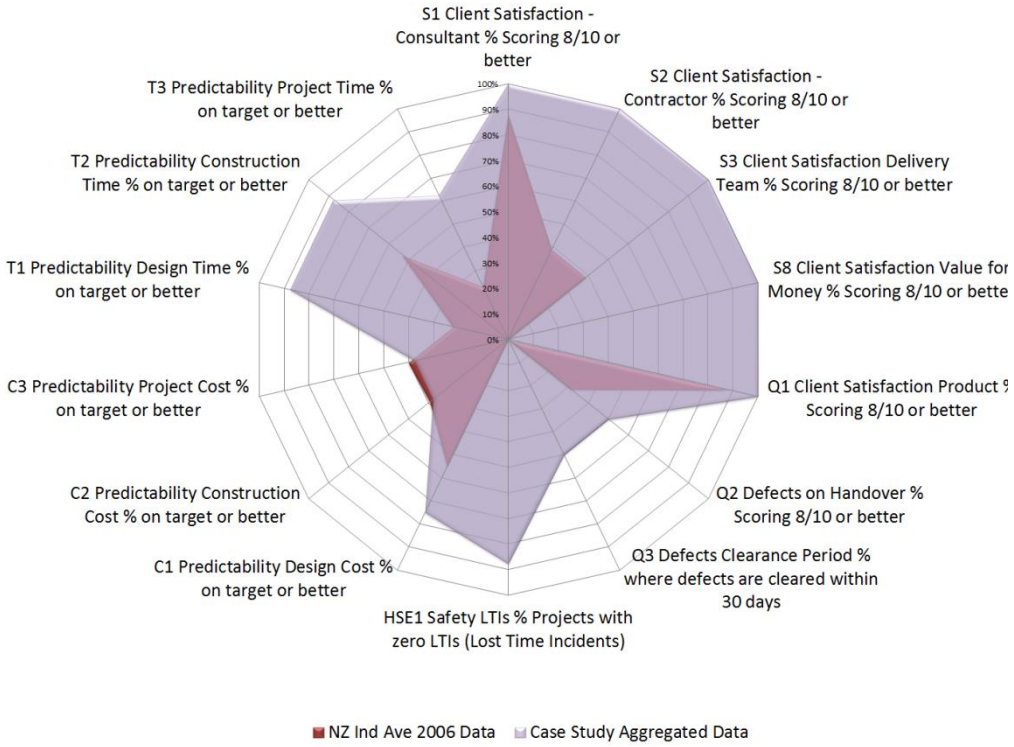
The table below shows that, with the exception of The Impact of Defects, Construction and Project Cost, the performance of the 8 projects measured benchmarks well with NZ and the UK. This confirms the view that these are successful projects.

Table 8.1 Aggregated Benchmark Results

KPI Suite	KPI	Measure - % Projects	Case Study Aggregated Data	NZ Ind Ave 2006 Data	UK Ind Ave 2011 Data	UK Demo Projects 2009 Data
SATISFACTION	S1 Client Satisfaction - Consultant	% Scoring 8/10 or better	100%	88%	86%	89%
	S2 Client Satisfaction - Contractor	% Scoring 8/10 or better	100%	39%	84%	92%
	S3 Client Satisfaction Delivery Team	% Scoring 8/10 or better	100%	39%	80%	92%
	S8 Client Satisfaction Value for Money	% Scoring 8/10 or better	100%	n/a	81%	n/a
QUALTIY	Q1 Client Satisfaction Product	% Scoring 8/10 or better	100%	88%	87%	89%
	Q2 Defects on Handover	% Scoring 8/10 or better	50%	31%	68%	86%
	Q3 Defects Clearance Period	% where defects are cleared within 30 days	50%	n/a	n/a	n/a
SAFETY	HSE1 Safety LTIs	% Projects with zero LTIs (Lost Time Incidents)	88%	33%*	61%	81%
COST	C1 Predictability Design Cost	% on target or better	75%	55%	79%	n/a
	C2 Predictability Construction Cost	% on target or better	38%	39%	59%	n/a
	C3 Predictability Project Cost	% on target or better	38%	40%	63%	88%
TIME	T1 Predictability Design Time	% on target or better	88%	22%	51%	n/a
	T2 Predictability Construction Time	% on target or better	88%	53%	60%	n/a
	T3 Predictability Project Time	% on target or better	63%	23%	45%	90%

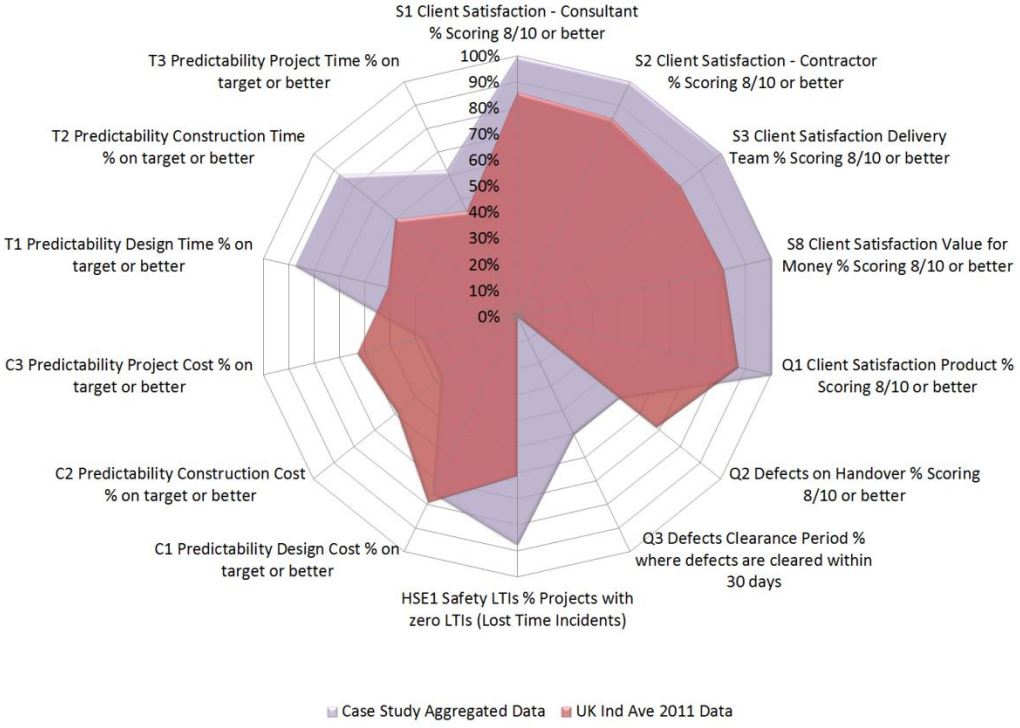
8.1.2 NZ 2006 Benchmark results

Figure 8.2 shows the aggregated projects' performance benchmarked with NZ National results for 2006. Please note the some KPIs show no data for the NZ 2006 Scores. Refer to the table in 9.1.1 for these.



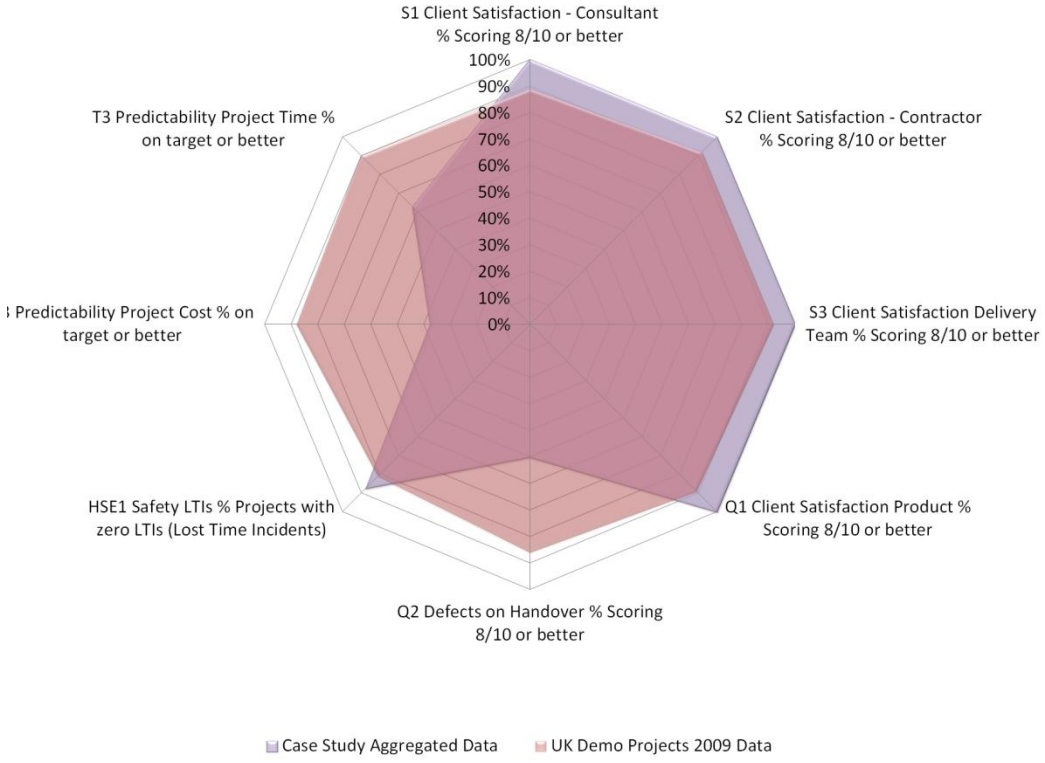
8.1.3 UK 2011 Benchmark results

Figure 8.3 shows the aggregated projects' performance benchmarked with UK National results for 2011. Please note the some KPIs show no data for the UK 2011 Scores. Refer to the table in 9.1.1 for these.



8.1.4 UK Demonstration Project 2009 Benchmark results

Figure 8.4 shows the aggregated projects' performance benchmarked with UK Demonstration Projects 2009 (the last tie the Demonstration Projects measures were formally published). The KPIs show no data for the UK Demonstration project set have been removed.



8.1.5 Early Conclusions

The results highlight the following:

- All the projects (100%) have achieved 8/10 or higher on the **Satisfaction** measures.
- The scores for the KPIs for **Quality**, (notably defects at handover) and **Predictability of Cost** are weak, (less than 50% of the projects achieved the industry targets, (Column 3 of Table 8.1).
- Whilst the scores for **predictability of Time** for **Design** and **Construction** are strong, the score for the **predictability of Project time** is weaker. This latter measure takes the clients planning time into account.

Early conclusions that can be drawn are:

1. **Clients' expectations are not high.** A project does not have to achieve high scores in all KPIs to achieve client satisfaction. Some of this may involve clients' ability to make changes during the project which are known and accepted. One example is the significant addition to scope on the Central Connector project which raised the cost but maintained programme and deadline.

   In addition, we know that the way the client is managed, during the delivery of the project has a significant effect on perception which can mitigate satisfaction perceptions in the light of lesser performing quantitative outcomes. i.e. a client that is well informed throughout can often withstand some delay to programme or cost overruns.

2. **The industry is not good at closing out projects well**. Defects at handover are expected and the very nature of the term 'Practical Completion' encourages this acceptance.

3. **Cost escalation** is accepted in the industry and arguably tolerated.

With the above in mind, what are the drivers for change? If clients tolerate and accept poor performance, how might the industry be stimulated into making a difference? With the prevalent form of procurement remaining at 'lowest price, hard bid', which usually bears no resemblance to output cost, where is the incentive for change?

8.1.6 Individual Project Results (Benchmarked against NZ 2006 results)

The following figures 8.5.to 8.8 represent individual project results.

Figure 8.5 PROJECT 02 AUCKLAND ZOO

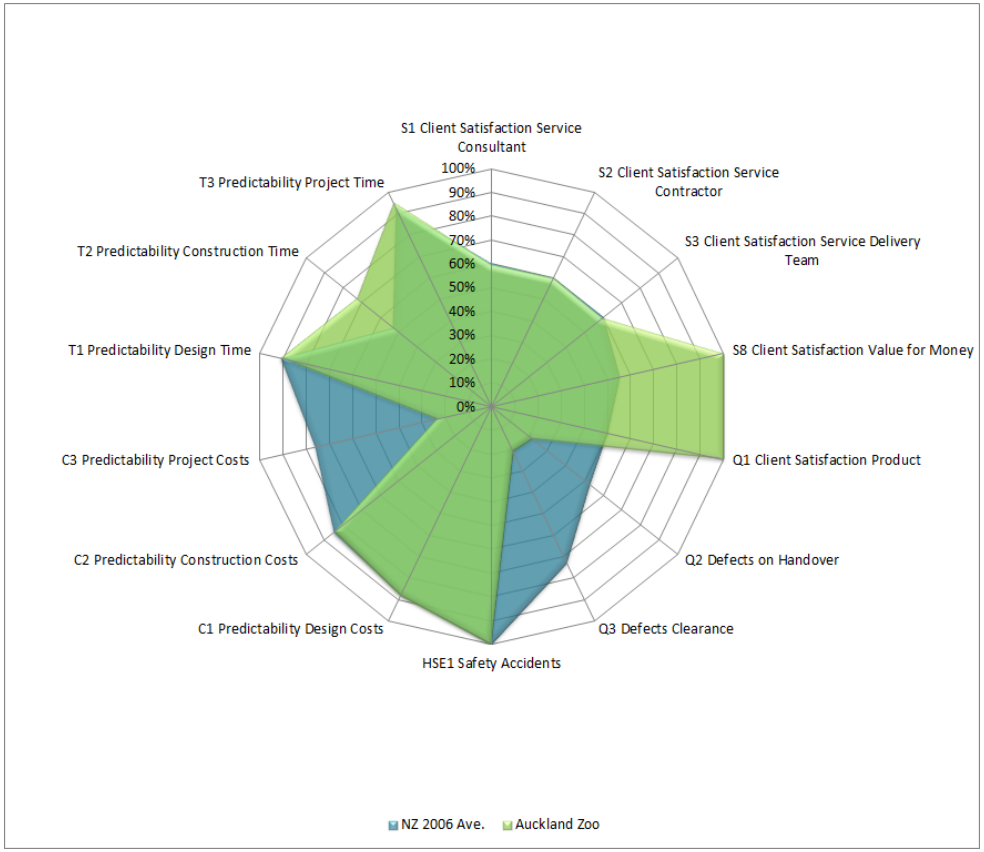


Figure 8.6 PROJECT 03 ALBANY SENIOR HIGH SCHOOL

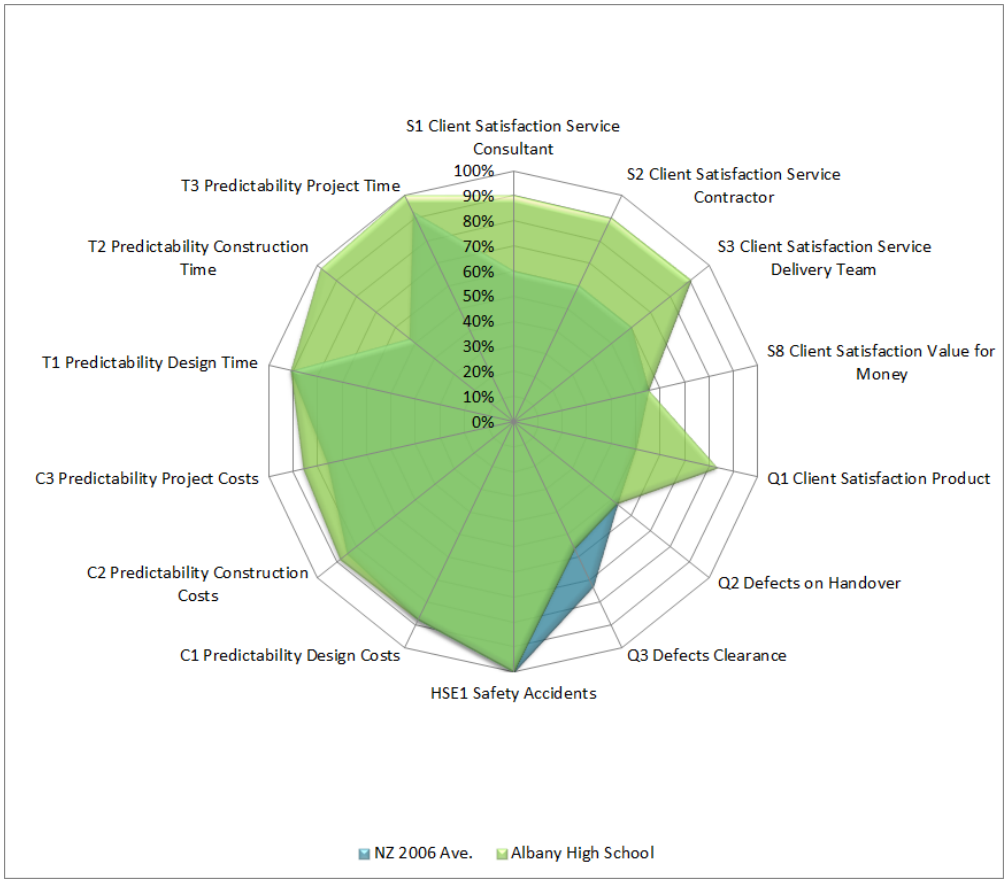


Figure 8.7 PROJECT 04 MIDDLEMORE HOSPITAL

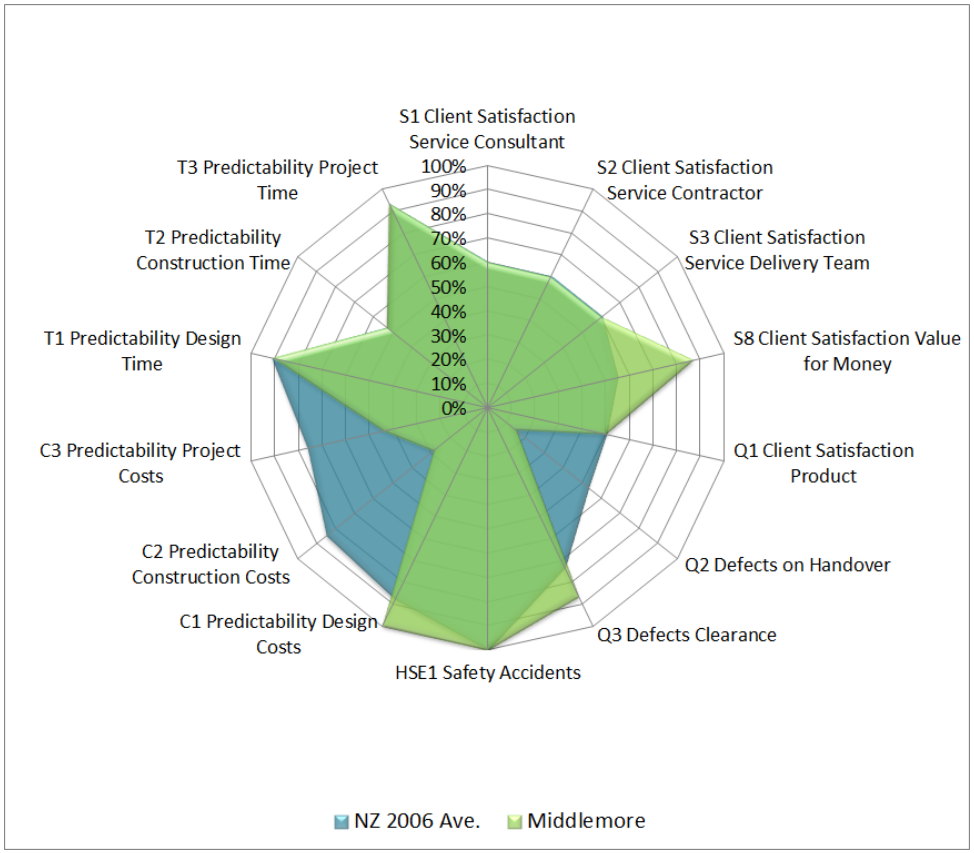


Figure 8.8 PROJECT 05 BRANZ REDEVELOPMENT

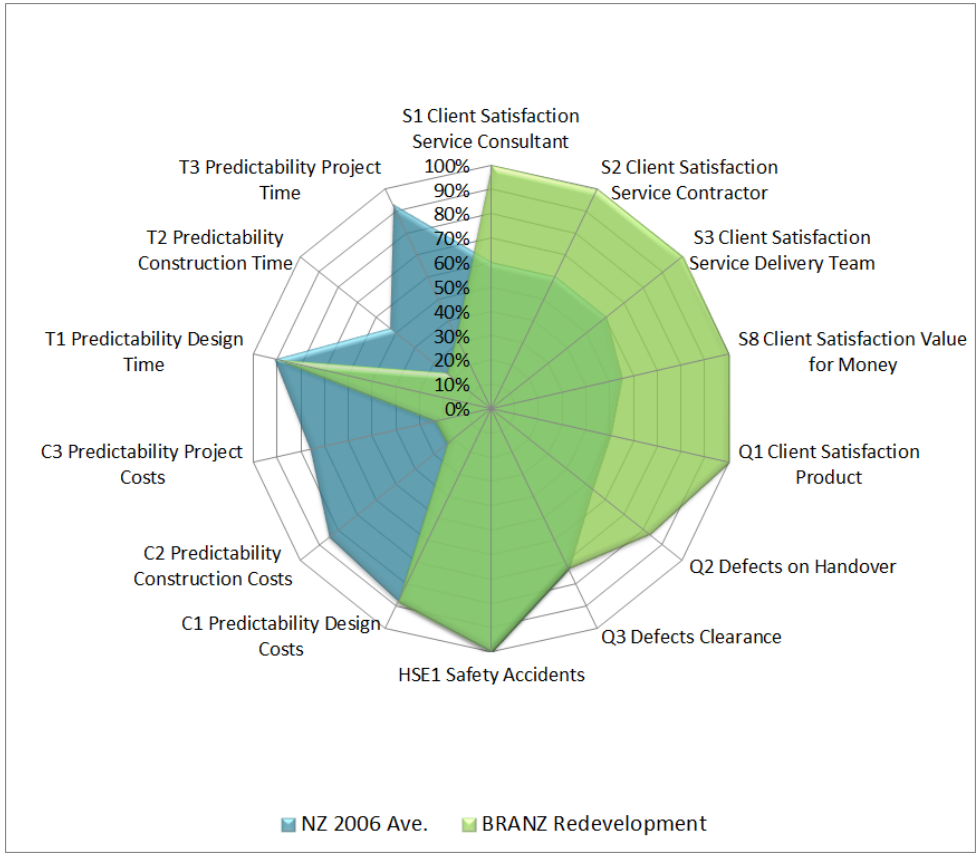


Figure 8.9 PROJECT 06 CENTRAL CONNECTOR

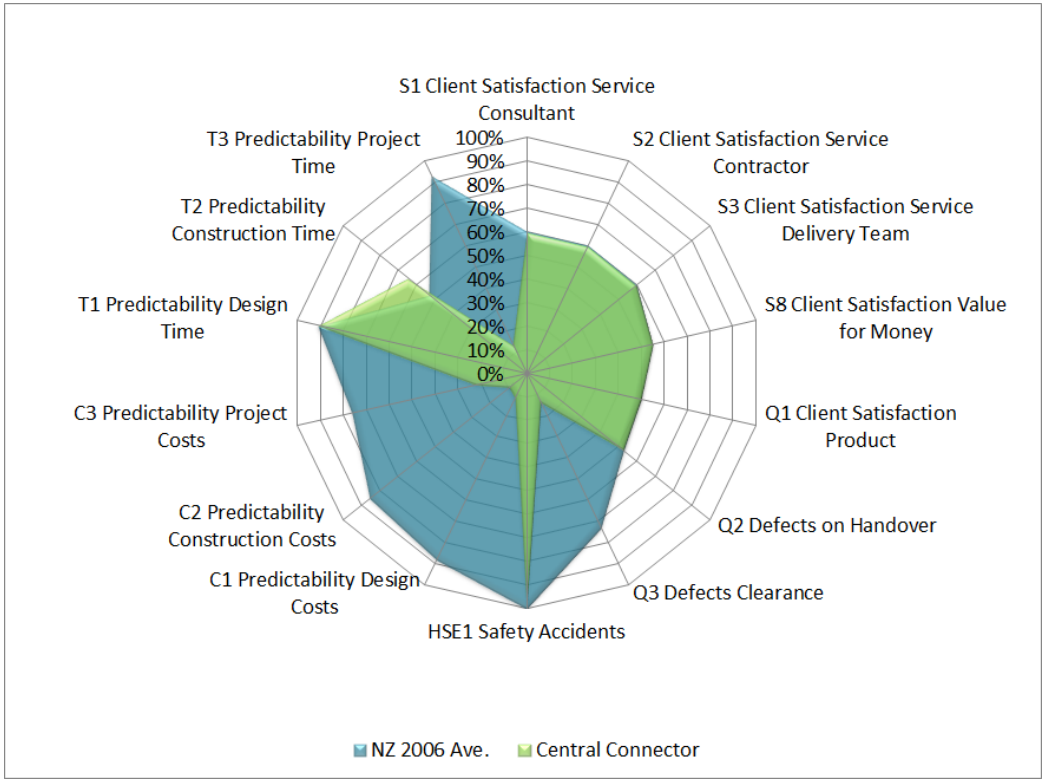


Figure 8.10 PROJECT 07 TE KURA KAUPAPA SCHOOL

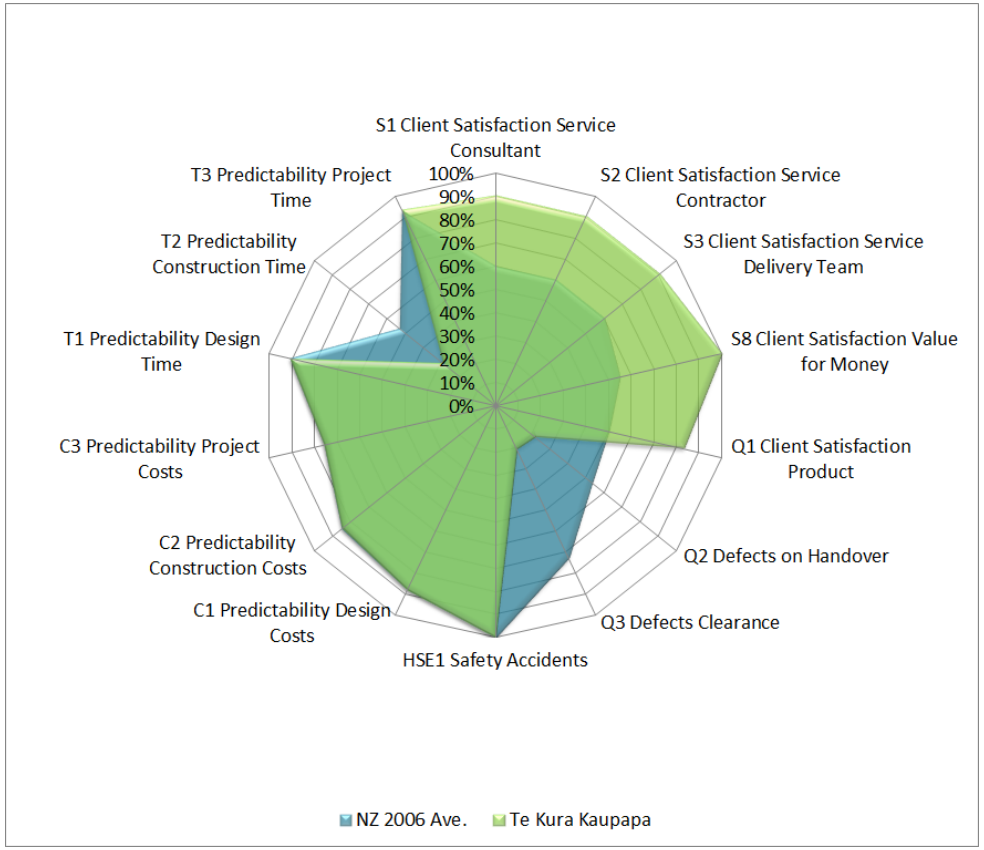


Figure 8.11 PROJECT 08 PALMERSTON NORTH CLOCK TOWER

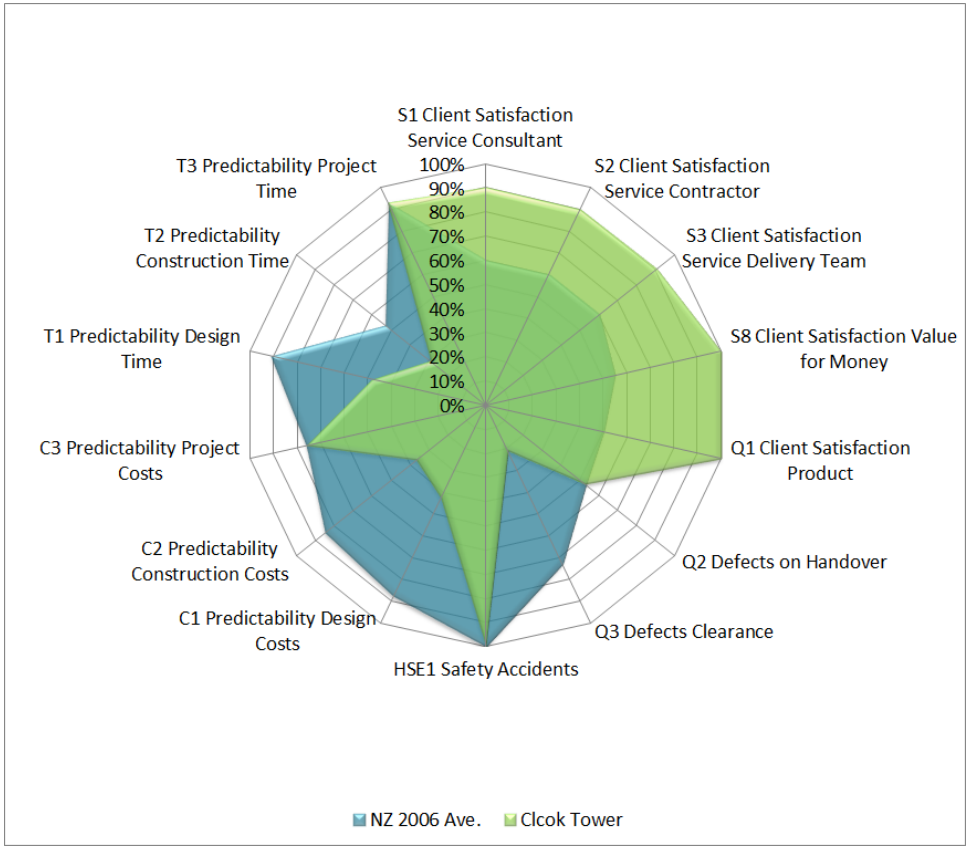
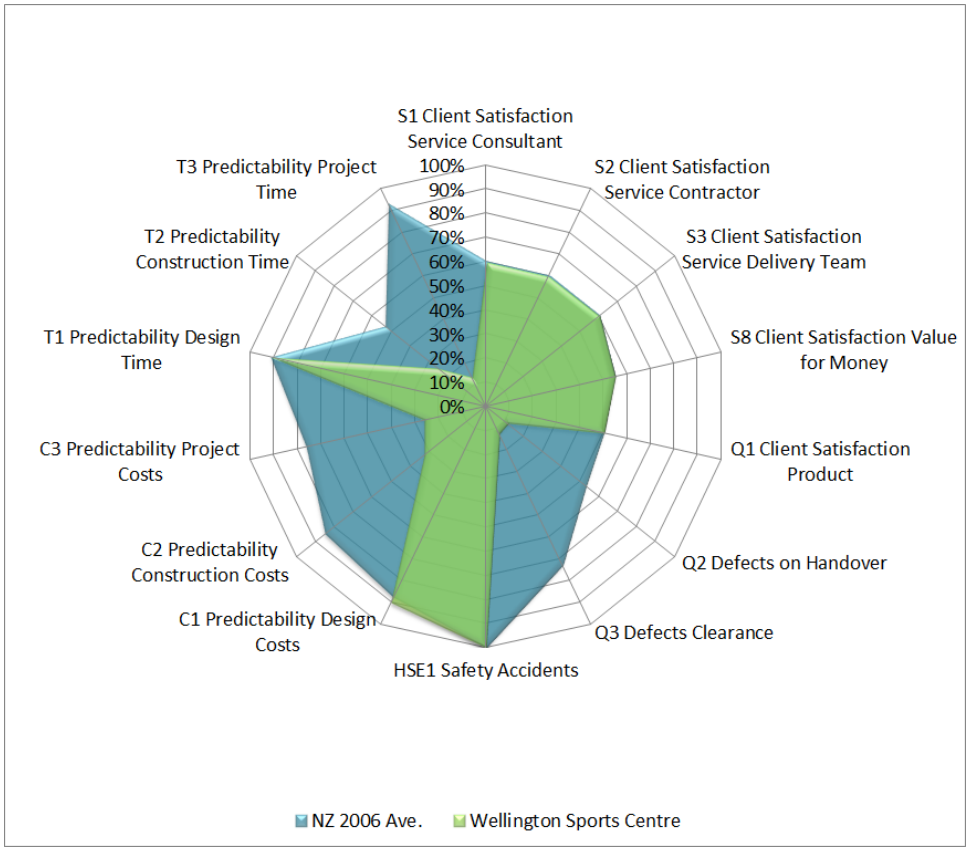


Figure 9.1.5.1 PROJECT 09 WELLINGTON SPORTS CENTRE



8.2 Construction Clients Group (CCG) Protocols Survey

The Construction Clients' Group (CCG) Protocol Survey has been developed from the Construction Clients' Charter which was first published in 2006. The intention of the Charter, developed by client members of the CCG, is to assist Clients to adopt best practice in behaviours of a Construction Client. The Survey enables them to self -measure by distributing to their supply chain members to score.

It was used for this exercise as a 360' review tool to examine client behaviours. The outstanding conclusion that can be drawn from the results is that for these projects, there is a high degree of agreement between the clients and suppliers on the levels of practice.

Figures 9.2.1 shows that The widest score gap is in the Clients' commitment to Sustainability. Clients are less convinced of their commitment than the Supply Chain.

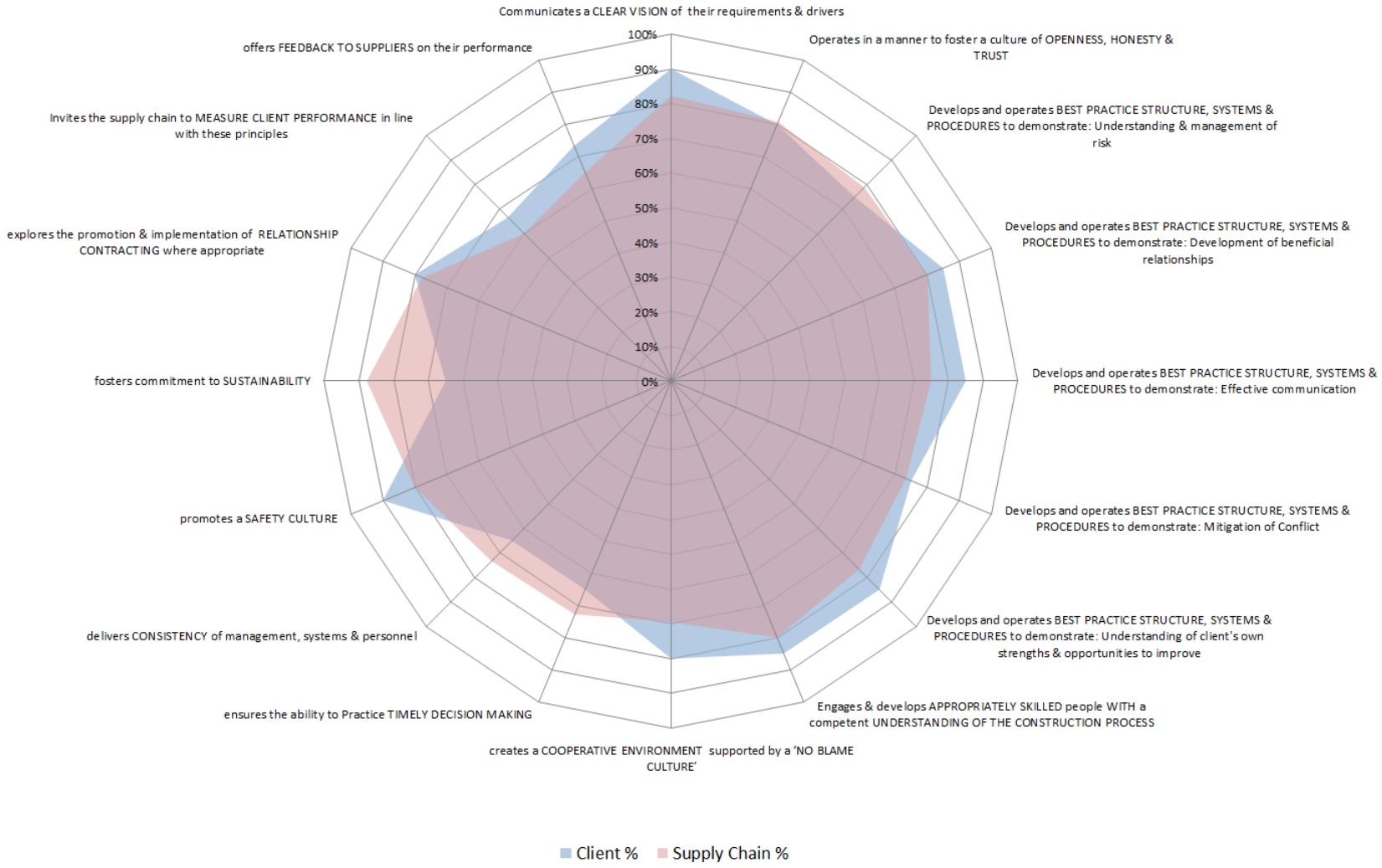


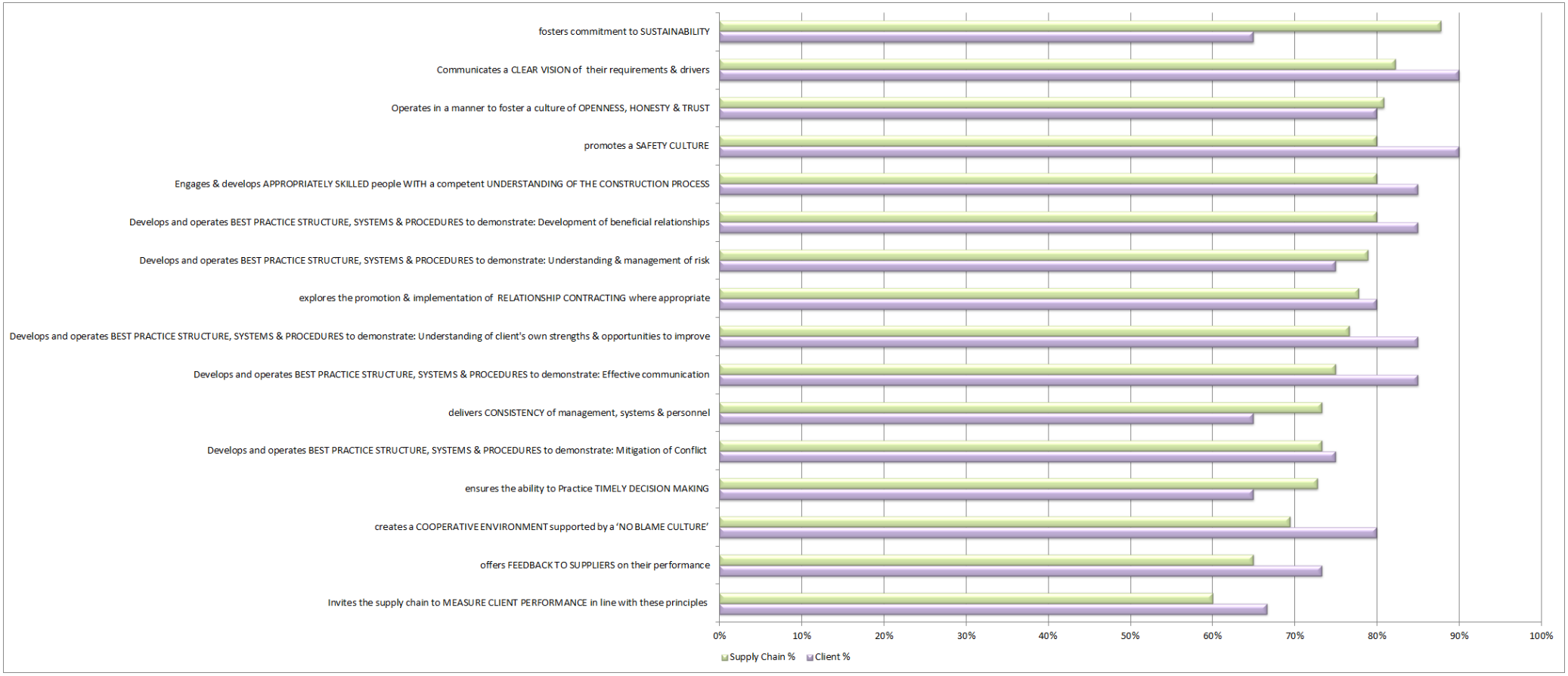
Figure 9.2.2 shows the order of scores by the Highest to Lowest scores delivered by the Supply Chain. It illustrates that the Supply Chain believe that the Clients highest scoring behaviours are:

- Commitment to Sustainability
- Communicating a Clear Vision
- Operating in a manner of Openness, Honesty and Trust

The Clients lowest scoring behaviours are aroudn:

- Offering feedback to the Supply Chain on their performance
- Requesting feedback from the supply chain on the clients own performance

This reflects the more typical project by project approach adopted by the industry which prevents supply chain and product based learning.



9 Conclusions and Recommendations

9.1 Developing the Framework

The framework that has emerged during this study can be mapped to the current structure of the Productivity Partnership. 'Procurement' and 'Managing Performance' map directly to the Procurement and Construction Systems work streams. Underlying the framework is the skills platform and overlaying it is the research component informing and providing a level of direction.

The theme which has dominated throughout this study is that of the 'Culture' of the industry, in particular, people's attitudes towards the industry and the part they play in it. This is arguably the single most important driver for success and productivity, yet is an area which is not overtly represented across most industry activities.

This framework might well be adopted by the Productivity Partnership as a planning tool for future programmes. To this end, it is important that Industry performance rises uniformly across all framework nodes. Their interdependence is such that the overall success of the 20/20 vision will be determined by the weakest link.

In short, we suggest that the worth of future programmes should be measured by the alignment of outputs with the framework and the level of impact it is likely to have at specific framework nodes.

We very much look forward to seeing this initial Framework being developed and built on for the future.

Figure 6.1 Framework for Productivity

10 What the Sector can do now.

In the course of this research, a range of drivers were identified which had already been successfully adopted on one or more of the targeted projects. They all had a clear impact on productivity outcomes, required minimal capital investment and hold few impediments beyond the collective will of project participants to utilise them. Some of these drivers involve the application of specialised techniques or processes; but for which access and training are freely available within New Zealand from a variety of sources. They are set out below under the established framework headings.

10.1 Client leadership

- **Skills**. Make leadership skills priority criteria in the selection of the primary Client representative.
- **Structure**. Establishing clear lines of responsibility and communication
- **Briefing**. Providing a clear brief accurately reflecting the project vision and the priority drivers.
- **Inclusion.** Willingness to share these visions and drivers with all members of the supply chain to create the understandings which underpin project culture.
- **Relationships**. Include in the Client brief a requirement for collaborative work practices at all levels in the project supply chain.

10.2 Procurement

- **Client Drivers**. Brief prospective professional services providers and Contractors on Client drivers and require counter-briefing as part of formal pre-engagement submissions to enable assessment of the level of understanding.
- **Leadership** . Assess and include leadership quality as an important part of the procurement process. This must extend beyond leadership within the organisation being assessed to the organisation's supply chain. Referencing supply chain experience is as important as referencing Client experience.
- **Risk.**Develop a risk management approach to procurement. Design the procurement process to de-risk the project across time, cost, quality and functionality.
- **Procurement programme**. Integrate the supply chain procurement programme as part of the risk management process recognising the opportunities which arisethrough early engagement. 'Buy your team before you feel the building coming on'

10.3 Defining the project for success.

- .**Whole of life.** Consciously consider as a briefing and design discipline the potential of whole of life and long term user productivity modelling.
- **Research.** Research and benchmark proposals against acknowledged 'pathfinders' internationally. Take the opportunity to set demanding performance criteria for both design and execution. Enter into the project on rising expectations
- **Deadlines**. Set and communicate clear and honest deadlines and build understanding around them. Manage changes to deadlines equitably.
- **Budgets**. Focus on building high quality cost plans; advancing design and taking advice as necessary to achieve this. This will

provide confidence in advancing early contractor engagement on attributes and running "open book" commercial processes. Share budget information.

- **Programme for planning**. Build planning time into programmes and remove any expectation of physical progress during these periods. The commencement rush is often the primary cause of the completion rush.

10.4 Culture:

- **Inclusion.** Develop a culture of inclusion by extending induction beyond process to include Client vision and drivers. Create the understanding of what successful execution will mean for the Client and have the Client share this directly at appropriate milestones.
- **Culture of 'Pull'**. Develop a culture of 'pull' rather than 'push'; one in which the second nature response to problems is "I can do this if….." rather than "I can't do this because."
- **Behaviours**. Regardless of how the project is procured, build a simple charter of agreed communication styles and behaviours
- **Communication networks**. Consider co-habitation for senior Client, professional services, Contractor and key supply chain personnel to take advantage of the resultant informal communication networks. Use formal communication processes more to confirm and less to formulate.

10.5 Managing performance

- **Collaborative Planning**. Establish a contractual requirement that all activity on the project is planned using a comprehensive collaborative process which as a minimum:
  - Involves all supply chain members extending to a task level.
  - Focusses on constraint removal. "We can if…."
  - Establishes and records commitments and rates performance against them.
  - Focuses on reasons for non-performance and feeds them back into the process
  - Provides a practical and efficient formal framework for leading the process and for record keeping.
- **Monitor 'soft' performance**. Establish a simple set of qualitative KPIs around charter behaviours and act definitively on consistent shortfalls
- **Monitor 'hard' performance** . Establish and monitor a set of quantitative KPIs measuring performance against time and cost and quality parameters. (Time would normally be monitored within the collaborative planning framework)
- **Lead Indicators.** Where possible establish lead indicators focussing on the processes intended to assure performance
- **Focus on forward risk.** Ensure that from the outset, formal project control forum agenda focus predominantly on assessment and mitigation of forward risk.
- **Common IT platforms**. Establish common IT platforms around BIM and 'Aconex' type applications. Apply them consistently and share the costs commensurate with the benefits, including those which remain post-project.

10.6 Close-out

- **Focus on completion.** Ensure that the project team is not dismantled or pre-occupied until the project is truly complete and without defect.
- **Performance measurement.** Measure and benchmark project performance against National and international performance standards. – Weighing he pig
- **De-brief.** Bring together the full project team including Client, professional service providers, contractor and supply chain for a candid facilitated project de-brief. Capture and distribute the learnings – fattening the pig.

11 Conclusions and Recommendations

11.1.1 Learning and Sharing

The first conclusion which can be readily reached is that there is much to be learned from studying successful projects and talking with skilled practitioners. Therefore, the first recommendation is:

1. ***Recommendation: Demonstration Programme:*** *Initiate a further ongoing programme of regular case studies similar to the BRANZ Pathfinder Programme. This programme should invite the industry to put forward projects which have been or are being planned to be innovative, productive and successful. The programme should be developed to monitor projects from beginning to end, rather than solely on completion. The UK Demonstration Programme has been cited as the single most important aspect for changing and developing Culture. Spotlighting success and providing a platform for learning and sharing have transformed an industry which was previously secretive and suspicious of sharing innovation.*

11.1.2 Culture

The second conclusion is around culture. Coming through very strongly is the need for the culture of a project and a team to be strongly aligned towards leadership, teamwork, collaboration, integrated teams and celebration.

Individuals are key to this through the leadership they provide. Leadership often came from the Main Contractor's project manager and the 'stars' of this exercise have often benefited from strong training programmes around performance improvement and a company culture of learning and development.

Most of the strong productivity drivers are 'soft' in an Industry with deep pride in its 'hard' skills. Therein lies the challenge. The second recommendation is:

2. ***Recommendation: Focus on Culture:*** *Initiate a programme of research and action around the culture of the industry. Measure it and encourage industry participants to engage with programmes which lift culture towards desirable outcomes. Examine other industries to see how they have tackled culture and raise the subject above the parapet so that it becomes and acceptable norm to demand a better culture.*

11.1.3 Performance measurement and Continuous Improvement

Section 8 shows that whilst the case study projects benchmark well against NZ and UK industries, there are clear areas for improvement. These include:

- Management of Quality, especially around defects
- Management of Cost
- Client planning activity (Predictability of project time)

The study shows that people generally are not concerned with 'Productivity' per se on a daily basis, rather they are focused on specific drivers of success which may or may not be directly related to productivity. On one project, for example, innovation was seen to hinder productivity through increased learning curves and that may be a valid business decision at the outset of a project. The point is that 'whatever gets measured gets managed'. Decisions on performance drivers need to be set, allocated targets and measured at the beginning, during and end of a project.

Overall, the industry needs performance measurement in order to a) understand where it is now and b) act as a driver and catalyst for performance improvement. It is helpful to have an industry set of standards to benchmark against rather than spend time re-inventing the wheel on each project.

The National Construction Industry KPIs, (section 8) have gained traction over the years with some 30 organisations now using them to drive performance and a number of benchmarking clubs have arisen during the last two years amongst local public sector bodies, all using the KPIs.

The Productivity Partnership is carrying out work around KPIs in Christchurch. Constructing Excellence and the CCG are developing a 2011 data set for their members.

Therefore, the third and fourth recommendations are

3. ***Recommendation: Promote Industry Performance Measurement and develop Productivity Measures:*** *A recommendation of this report is that the Productivity Partnership works with these organisations to develop a National Data set to replace the 2006 outdated measures available.*

   A further recommendation is that the industry develops a suite of measures of productivity that a) makes sense at a project level and b) enable the industry to see its progress. The UK publishes an industry report annually with some 12 years of data available across a range of KPIs. It is clear to everyone in the UK construction industry how the industry performs.

4. ***Recommendation: Focus on Quality and 'Defect-Free' outcomes .*** *The performance measures in section 8 show that this is the weakest area of performance in the industry. The industry is not good at closing out projects well. Defects at handover are expected and the very nature of the term 'Practical Completion' encourages this acceptance. A recommendation of this report is to carry our research into the nature of defects and initiate a programme for the industry to develop guidance and tools around achieving defect free performance.*

11.1.4 Procurement

the importance of long-term relationships with integrated supply teams working collaboratively together to focus on the 'Product' is a loud message coming from all the projects.

The relationship can be client driven through procurement or industry driven through consortia and collaborations.

Without long-term relationships with repeat projects being delivered by teams who formally operate continuous improvement programmes, the industry will probably still be delivering its products in a similar manner in 100 years to those of today.

Figure 9.2 illustrates how teams can develop long-term learning outcomes around a programme of projects.

There is much misunderstanding amongst clients on the subject of procurement. Many public sector clients believe that they must competitively tender every project. This drives waste into the industry and removes the opportunity for learning and development of a team that stays together long term.

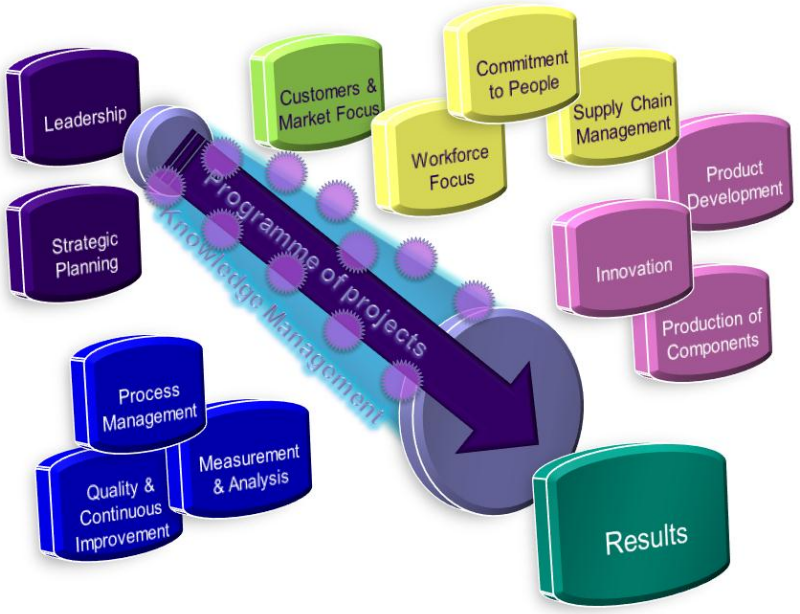


Figure 9.1 A model for 'Product Development' through long-term integrated supply teams.

The industry needs better guidance around procurement. Therefore, recommendation No. 4 is:

5. ***Recommendation: Develop guidance on procurement*** *and promote the use of long–term relationships and integrated collaborative teams. This might take the form of:*

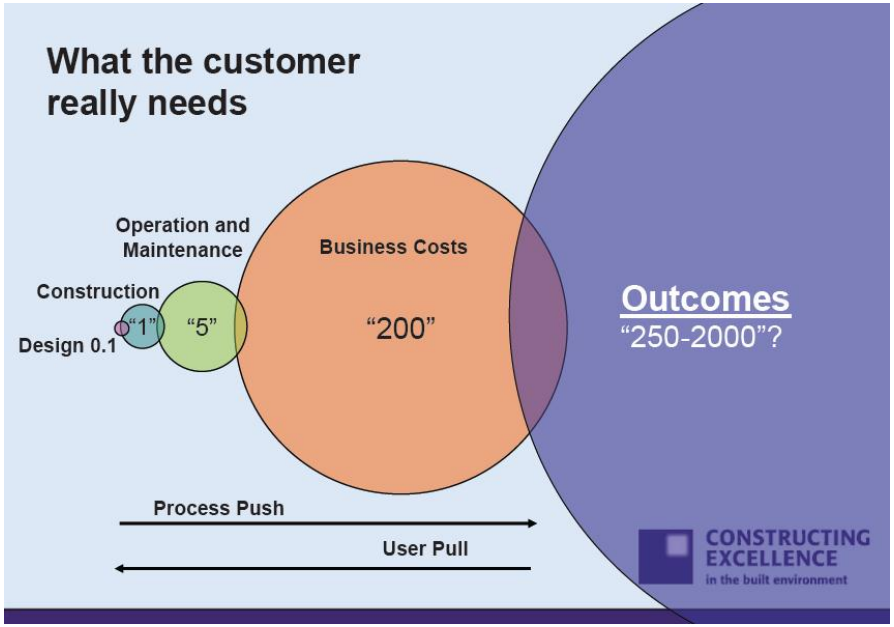
- Research further the tools for collaborative working and deliver guidance to the industry in the form of best practice tools and education material.

- Engage with clients and educate them on the 'rules' illustrating how they can innovate using case study examples and step by step guides.

11.1.5 Product Development

A reminder of the ultimate and potentially most potent productivity measure has emerged from this exercise. That is the opportunity for real economic benefit which is available by focussing the team on the productivity of the developed asset, or 'Product'. The 1:5:200 model (Figure 6.1) illustrates this well.

6. ***Recommendation:*** *Develop the 1:5:200 model for specific products in New Zealand, (Further research is available from the BeValuable report*). Encourage clients to think about the long-term productivity benefits available through this approach.*



11.1.6 BIM and BEIM

It is clear from the findings of this study that many believe in the ability of BIM and BEIM to be a significant driver in the bid to improve the industries productivity. In the automotive industry, moving from craft based production to mass production, technology was the single most influential factor.

There are many issues around the successful implementation of BIM/BEIM, not least the technology issues around platforms and interoperability. In addition, investment, culture and the typical small size of many NZ organisations all play their parts.

The Productivity Partnership is currently pursuing a BIM/BEIM programme, therefore the recommendation of this report is simply to continue to pursue this endeavour.

7. Recommendation: Develop a research and action programme designed to assist the industry to successfully adopt BIM/BEIM.

11.1.7 Lean Construction

There is much evidence from the projects examined in this study that the beginnings of Lean Construction principles of removing waste or Muda from the process are appearing across new Zealand. These principles, originally developed by Taiichi Ohno and further refined through the Lean Construction Institute have been used successfully applied for several years in the US and UK amongst other countries. In particular, the lean tool, Last Planner has been significantly successful in helping teams to collaborate on planning and deliver projects on time.

8. Recommendation: Develop further research into Lean Construction principles and their impact on productivity.

11.1.8 Modular Building/Prefabrication

Where used appropriately, this discipline has an 'game-breaking' impact on productivity. The process dramatically increases productivity as whole systems (walls, roofs, bathrooms etc.) are developed in a controlled environment with lower skill levels, (using manufacturing processes) than those required on site and in a safer environment. On-site delivery timescales can be significantly reduced. Where whole facilities are built off-site, clients can achieve 'turf to operation' in a matter of days. The process in itself forces a level of integration beyond that of even the most integrated team on a traditionally built project. The product is literally 'Designed for manufacture' (a Lean Construction Principle) with tolerances that are similar to aerospace.

New Zealand has an issue of scale. The investment to deliver such results is significant. Prefab NZ is doing much to develop and deliver the knowledge around this form of construction and have made significant progress. The volume of information locally and nationally is large and readily available, therefore, a recommendation of this report is:

9. Recommendation: Working with Pre-fab NZ, develop a research and action programme focussed on reviewing the opportunities and blockers of implementing Modular building/prefabrication on a large scale in NZ.

11.1.9 Futher Recommendations

In addition to the recommendations above, this report recommends the following:

10. ***Socialise the findings*** *through presentations and workshops.*
11. ***Open a forum*** *for receiving feedback on the productivity drivers.*
12. *That the framework of productivity drivers be used by the Productivity Partnership for* ***future programme planning and delivery****.*
13. *That the Productivity Partnership Initiate the development of* ***'Productivity Best Practice' guidance tools*** *aligned to the framework of productivity drivers possibly in collaboration with other representative sector and industry groups. Specific subject areas for inclusion could be:*
    a. *BIM/BEIM*
    b. *The development of Culture*
    c. *Procurement for long-term relationships*
    d. *'Product' Development in the industry*
    e. *KPIS and benchmarking*
    f. *Lean Construction*
14. *Follow up on the development of Productivity best practice guidance tools with the sponsorship of a complementary set of* ***training tools****.*

11.1.10 Final Note:

This project has been incredibly rewarding in that the volume of emerging data around the goal of improving productivity has proven to be vast, albeit covert.

The raw findings which are set out at Appendix C are a rich source of further analysis and we recommend this.

In drawing conclusions, we are aware that there may be areas of importance which will be obvious to others that have not occurred to us and perhaps have not made it into the recommendations. We therefore, welcome a collaborative approach to further developing the recommendations. The list in this section is not exhaustive.

Overall, it is clear that comprehensive leadership is essential to activating the more critical productivity drivers.

Leadership and the concepts of collaborative working and process integration must become central to industry training and not a 'clip-on'.

Our new entrants need much greater exposure to other industries and we need to look closely at the relevance of the demarcation of trades based on 100-200 year old craft boundaries.

We look forward to the future with anticipation of many tangible outcomes conjoining to support the goal of the productivity Partnership to achieve a 20% increase in Productivity by the year 2020.

Appendix A – Interview Template

1	Why do you consider this project to have been a success?
2	Can you relate the project's success to any specific factors or initiatives? Can you prioritise these?
3	How do you gauge project productivity?
4	Do you think this project represented a low, average or high productivity outcome?
5	Did you have any benchmark information for this type of project?
6	To what degree did whole of life costs factor into project planning?
7	Please describe to what degree and how the following impacted on productivity on the project; examples where possible:
7.1	Client Leadership
7.2	Relationships between the industry stakeholders
7.3	The Contract conditions
7.4	The Procurement process
7.5	The design process and its integration
7.6	The construction process
	7.6.1 IT technologies. (e.g. BIM, programming or financial applications, web based communication tools)
	7.6.2 Alternative construction techniques, technologies or project specific innovations
	7.6.3 Approach to scheduling and programming
	7.6.4 Attitudes and initiatives around continuous improvement and driving out waste in the course of the project
7.7	Use of KPIs and performance measurement as management tools
7.8	Skills and Capabilities (Managerial and Technical)
7.9	Level of integration throughout the supply chain
7.10	Attitudes and Processes around Safety
7.11	Development of Project Culture including celebration of success

Appendix B Summary of Interview Outcomes

This section provides a summary of the feedback under each of the questions for this project using the interview template:

1	Why do you consider this project to have been a success?	• Strongest indicator of 'success' is Client or stakeholder satisfaction. • Constructors have secondary indicator around commercial success. • Success was consistently measured against the traditional time, cost and quality measures • Secondary success indicator was around the generation of an exceptional project culture
2	Can you relate the project's success to any specific factors or initiatives? Can you prioritise these?	• Establishment of a collaborative culture (demonstrably possible under a wide range of contract environments). • Good understanding of Client drivers. • Mutual respect – expressed in a number of different ways. • 'A' team skills and attitudes underpinned good results implying that the 'B' teams would not have been good enough. • Positive and collaborative cultures were a strong common success driver. • Auckland Zoo's success drivers signal this as an exceptional project with broadminded stakeholders. Gem: Outstanding design or execution conspicuously absent as a success driver.
3	How do you gauge project productivity?	• Productivity perceived as strongly related to execution and the traditional time/cost/quality triad. • In two cases Clients related productivity to levels of long term organisational benefit. • Thinking around productivity limited to production although there was a consistent interest in measurement by Contractors, and in two cases some sophistication • Little evidence of productivity being considered at a higher level. Architects had little understanding or apparent interest in embracing the concepts. Gem: Relating risk sharing/mitigation to productivity. "If we're not fighting time we can fight risk." "A good procurement process is one designed to de-risk". "Risk sharing is a key productivity factor".

4	Do you think this project represented a low, average or high productivity outcome?	• Near universal view that high productivity results were achieved. • Strong correlation between success drivers and productivity drivers. • Little feeling for productivity as a 'unit' phenomenon. • View of productivity significantly mirrors views on success with time and cost outcomes common indicators • Interesting suggestion that Contractors are more productive in tight times. Given that 80% of production is generally in the hands of a supply chain also suggests that commercial pressure is raised. Does striking a harder bargain represent increased productivity?
5	Did you have any benchmark information for this type of project?	• Benchmarking largely broad-brush and historic. • Thinking around benchmarking focussed on cost. "Making sure we don't pay too much". • Accountabilities set around meeting rather than beating benchmarks. • Two Clients held the view that project performance was a much less critical variable than long term benefits delivered to the organisation through the environment which had been created. • Two projects considered unique with benchmarking of limited relevance. • Two relied on extensive general databases for historic information.
6	To what degree did whole of life costs factor into project planning?	• Quite variable understanding and application of WOL principles. • Government policy significant in levels of adoption. Evidence of mixed messages with incompatible capex and opex funding models. • Some suggestion that Local Government more advanced in thinking than Central Government . • Limited facility life on two projects led to focus on introducing recycling through ability to salvage and adapt to a new site. • NZDF leveraged lower opex off capex

7.0 Please describe to what degree and how the following impacted on productivity on the project; examples where possible:

7.1	Client Leadership	Importance to Productivity Score (10 = High) 7.5/10 av. Range 6.5-8.0+

		• A common theme. An active, accessible and interested Client with authority has considerable influence. • In one case, Client was not technically 'intelligent'. However, clear and consistent demarcation worked well. • Good brief is part of the leadership package. • Consistent theme around clear briefing and a single client contact point with appropriate authorities. • Underlying theme that the Client's understanding of the critical drivers and ability to reflect these in Contractor selection is significant. • Client management of internal stakeholders/users is important
7.2	Relationships between the industry stakeholders	Importance to Productivity Score (10 = High) 7.5/10 av. Range 5.5-9.0 • 3 out of 5 projects saw stakeholder relationships as their primary productivity driver. • Trust and mutual respect are the key factors. • Value of holding teams together for multiple projects emerges. • Longevity of relationships consistently commented on and in one case the opportunity to undertake a repeat project with the same team seen as a major driver. • Opportunity to generate a special flavour through acknowledgment of skills and expertise or the 'specialness of the task at hand specifically noted.
7.3	The Contract conditions	Importance to Productivity Score (10 = High) 2/10 av. • Simply not seen as a significant potential productivity driver. • Contract conditions simply seen as tools with which teams had to be familiar. • No impact on productivity
7.4	The Procurement process	Importance to Productivity Score (10 = High) 6.5/10 av. Range 2.0-9.0 • Highly variable response. • Lowest score was on a project on which there was demonstrably high production productivity through outstanding leadership and in spite of traditional procurement process.

		• Highest score on project where ECI was heavily exploited. • On the first four projects, each had a significant level of attribute weighting. As importantly, several gave the Contractor the opportunity to select Subcontractors albeit to bid on lowest cost conforming basis, Degree of consistency across procurement of MC then SC seen a significant productivity driver.
7.5	The design process and its integration	Importance to Productivity Score (10 = High) 6/10 average. Range 4.0- 8.0 • Highest score where buildability and developed design were interdependent. • Buildability input to design seen more as "build process risk mitigation" around detailing than a significant design influencer. However, either way integration still seen as a solid contributor to productivity. • Good long term relationships were a common catalyst for integration of the design process. Formal definition of process, ECI/D&B etc of little consequence if leadership and team chemistry is good. Integration then occurs naturally.
7.6	The construction process	
	7.6.1 IT technologies. (e.g. BIM, programming or financial applications, web based communication tools)	Importance to Productivity Score (10 = High) 4.5/10 av. Range 2.0-6.0 • Most comprehensive use and perceived value was in transportation solution modelling. • BIM raised modest enthusiasm. Seen primarily as demonstration tool. Where it was used more extensively, platform and currency issues limited its potential. • Web based administration tools given some attention. • Consistently BIM is being ignored or use limited and localised. Contractors more inclined to lead simply to pick up production productivity gains.
	7.6.2 Alternative construction techniques, technologies or project specific innovations	Importance to Productivity Score (10 = High) 5.5/10 av. Range 4.0-8.0 • Considerable uncertainty around what innovation looks like and a certain 'coyness' about claiming credit. • Higher levels of collaboration seemed to generate higher on-going levels of innovative thinking but lower levels of acknowledgement. "It's what we do". • Stand-out technologies included:

		○ a comprehensive application of lean construction principles ○ Modular construction. • Comments around modular "shop drawings reflect the need to pay attention to the lead skills.
	7.6.3 Approach to scheduling and programming	Importance to Productivity Score (10 = High) 5.5/10 av. Range 3.0-8.0 • 4 out of 5 projects used collaborative planning techniques. Of those, three used 'last planner' style 'future constraints' based framework. This is an important linkage. • The 5th project relied on a very experienced PM using traditional, non-collaborative, 'earliest start' approach to reasonable effect. • 'Time to plan' was a common ingredient in very successful programme outcomes and was linked by these interviewees as key to productivity. [Linked also with provision of mature documentation by some]. Counter to sector's tendency to rush the start at the expense of the finish. • Several of the project teams saw collaborative planning frameworks as a strong productivity driver • NZDF demonstrated that traditional planning techniques are effective, but in the hands of an 'A' team.
	7.6.4 Attitudes and initiatives around continuous improvement and driving out waste in the course of the project	Importance to Productivity Score (10 = High) 5.5/10 av. Range 3.0- 7.0 • Planning and 'time to plan', especially when built into the programme, was a significant driver of continuous improvement. Collaborative planning with performance monitoring provided a good platform. • Perceptions of waste reduction went well beyond the physical. A reasonably consistent understanding around the gnawing waste in poor process. • Continuous improvement as a philosophy strongly present in one project; a little more as a consequence of traditional management practices on others. • Physical waste reduction common. "low hanging fruit of" sustainable construction.
7.7	Use of KPIs and performance measurement as management tools	Importance to Productivity Score (10 = High) 5/10 av. Range 2.5 -7.5 • The two highest scorers used simple qualitative dashboards focusing on a range of relationship and production based parameters prepared monthly.

		• Only one monitored unit production (as a measure of baseline productivity). • KPIs were largely historical with virtually no use of lead indicators. • Three projects (two Constructors) running Industry KPIs. • Very limited use of internal KPIs to monitor key productivity drivers in the course of projects.
7.8	Skills and Capabilities (Managerial and Technical)	Importance to Productivity Score (10 = High) 6/10 av. Range 3.0- 7.5 • General recognition that leadership drawing on all skill sets is significantly more influential than absolute individual skills. • One project was anchored by an outstanding concept which created a productive outcome in spite of a range of difficulties. • Evidence that individual skills were significant on one of four projects • Generally limited recognition of skills as productivity driver, however.
7.9	Level of integration throughout the supply chain	Importance to Productivity Score (10 = High) 5.5/10 av. Range 3.0-7.0 • The approach to this remains relatively unsophisticated with communication generally on a 'need only as I see it' basis rather than 'communicate widely except when I can't'. • Collaborative planning techniques are seen as the key to supply chain interaction by those who have taken the plunge. Scores reflect stronger perceived linkage to productivity. • High levels of supply chain integration on three of four projects through formal collaborative planning. Considered a strong productivity driver. • Creating wider understanding provides important element of integration for SC. • Stark contrast with traditional approach on NZDF where MC negotiated stage 2, but SC procurement and management regime not aligned with classic consequences.
7.10	Attitudes and Processes around Safety	Importance to Productivity Score (10 = High) 6.5/10 av. Range 5.0- 7.0 • Safety seen as a significant lead indicator to other productivity related parameters.

		• Safety attitudes and performance mirror overall performance. One view that this impacted directly on productivity. • Modular work highlighted the impact of moving construction elements to a controlled environment
7.11	Development of Project Culture including celebration of success	Importance to Productivity Score (10 = High) 6.7/10 av. Range 4.0-8.0 • Culture isn't 'beer and skittles' • Conscious development of a working culture highly rated by those who did. • Leadership of culture development can come from any active and influential person in the team. • Culture must be monitored and shifts acted upon. The people must be 'fit for project'. • Seen as a strong productivity driver. • Creating understanding around the project 'story' seen as important part of culture forming • Specialness in both product and team.

Appendix C – Individual Project Case Studies

Appended as a separate document